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QUARTERLY

OF THE

National Fire Protection Association

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40 CENTRAL STREET, BOSTON, MASS.

National Fire Protection Association.

INTERNATIONAL.

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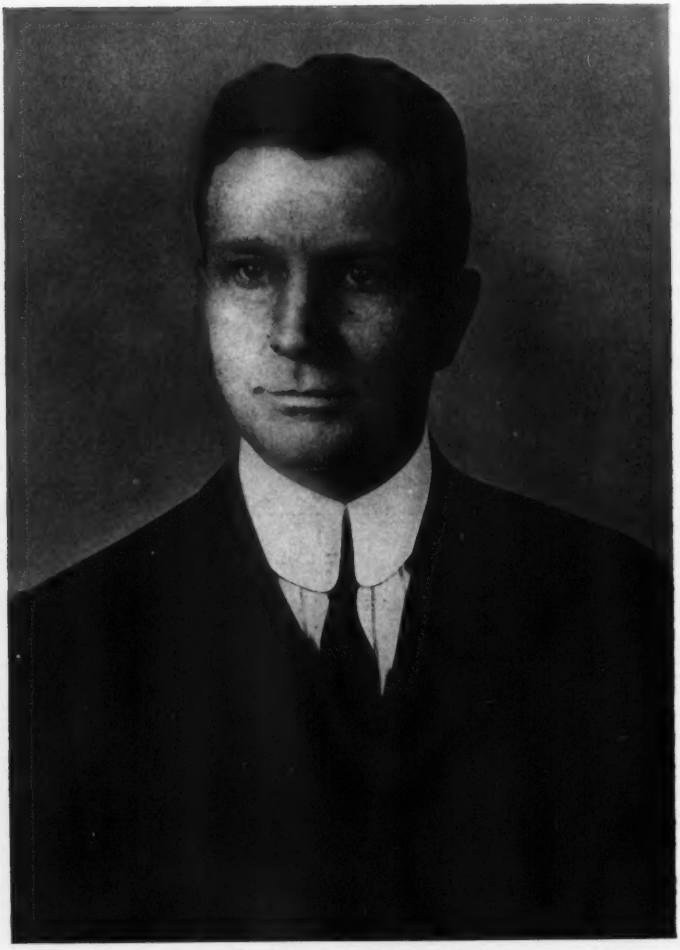
Reports of fires appearing in the Quarterly are copies of or extracts from written reports forwarded to the Association. This Association, as a body, is not responsible for the statements or opinions of any of its members.



Fenwick J. T. Stewart

Chairman Executive Committee 1911-1918. President 1918-1920.

The fire waste is the main support of the family whose father and mother are Ignorance and Indifference and whose child is Carelessness.

—*Albert T. Bell.*

The Quarterly

Vol. 18 **October, 1924** **No. 2**

The Passing of Mr. Stewart. Among all the men who have contributed the best that was in them to the success and upbuilding of the National Fire Protection Association, F. J. T. Stewart held no second place. Patient, kindly, untiring, competent, Mr. Stewart served the Association early and late with unwavering devotion. No hours were too long, no task too arduous to turn him from his accomplishments. He finished the jobs he tackled even if he had to finish them alone. He was always a mediator; his qualities of heart made this service natural to him. No one, however much he might feel disappointed at its result, ever went from a business or engineering conference conducted by Mr. Stewart with any feeling of slight or resentment. He was eminently reasonable and fair. Time and again in conventions of the Association, when a member through timidity or inexperience in speaking had failed to make clear the idea he was endeavoring to present, Mr. Stewart would rise to his feet before the chairman was permitted to dispose of the matter and in his slow and deliberate speech clarify and commend the thought of the timid speaker. These were generous and loving acts that men will remember even when his competent engineering contributions are forgotten. He will be remembered; he cannot be replaced.

* * * * *

Uberto C. Crosby Dies. Just as we go to press the news is received of the death at the age of 77 of Uberto C. Crosby at his summer home in Nantucket, Mass. Mr. Crosby was the first honorary life member of the N. F. P. A., having been accorded that honor in 1901. Mr. Crosby was also the first chairman of our executive committee and our second president, serving in the latter office for the years 1897-1900. The Crosbys, father and son, were responsible for the foundation of the N. F. P. A., the son, Everett U. Crosby, well known in insurance circles, being the first secretary, acting in that capacity for seven years. Uberto C. Crosby never lost interest in the work of the

N. F. P. A., to which he was of notable assistance in the early years of its development. He was a leader in recognizing the value of the automatic sprinkler. Probably few remember the sprinkler installation in the barn of the Crosby home in Newton, Mass., where certain men now high in the service of the great fire insurance companies made their first contact with this device. Mr. Crosby was widely known as an insurance company executive. Few men have retired from executive positions and taken into private life a higher regard than Mr. Crosby. He was a just man, with great kindness of heart, beloved by all members of our Association who had the privilege of his acquaintance.

* * * * *

The Field Secretary's Work. The members of the Association, and particularly the devoted minority whose voluntary contributions made possible the creation of our field service on July 1st of this year, would be profoundly interested if it were practicable for us to publish the story of local conditions in certain cities that Field Secretary Bugbee has already visited. The amazing revelations of these visits indicate what a tactful and intelligently administered field work should accomplish. In a city having an average per capita fire loss of more than $10 for the past five-year period, the city manager had not reviewed the report of a local survey by the engineers of the National Board of Fire Underwriters published three months before; in another city with an average per capita loss of $9.33 for a similar period, the officers of the local Chamber of Commerce did not know the local burning rate was high; in another, the capital of a state, the city was allowing the state to operate a combined garage and saw-mill, the saw-mill above the garage with unprotected openings from one story to the other, close beside a large hotel; in another, where Mr. Bugbee was invited to inspect the public schools, he found carbon-tetrachloride extinguishers inoperative in six schools out of the ten inspected and in one a complete equipment of extinguishers of the soda-acid type which had been installed at their locations but never charged; in another a factory employing 100 girls on the third floor had an outside iron stairway, to which access was provided by a window swinging outward over the entire area of the small grill platform and when open absolutely blocking exit from it.

In every city so far visited, however, our work has met with a most cordial reception from the officials and citizens alike. Eagerness has been shown to correct at once glaring defects involving danger to life and to consider favorably suggestions for improvements calculated to better the common fire defense. As far as diplomatic considerations will permit, and a sympathetic regard for the sensitiveness of the authorities in many cities who are showing so fine a spirit may allow, our field secretary's work and its results will be chronicled from month to month in the

News Letter. It can be fairly said that the results already achieved by our field work fully warrant the sacrifices involved in undertaking this new service.

* * * * *

Distinguished Organizations to Help. Present achievements aside, however, recent official action on the part of other large and influential organizations co-operating with the N. F. P. A. make our new field secretaryship an almost indispensable agency. The fire waste council of the Chamber of Commerce of the U. S. A. has created a field service committee to assist local chambers in making their fire prevention work effective. Without the services of our field man which we are placing at the command of this new council committee, its operations would be confined to correspondence. The new joint fire prevention committee created by the coming together of the N. F. P. A., the American Water Works Association and the International Association of Fire Engineers would also be constrained to the carrying on of its work by correspondence alone were it not that our field secretary is available for special service. In addition to these two important committees which we may serve in the field and which in their turn may make our field work effective, there is our most stimulating and helpful alliance with the National Safety Council with its forty local organizations, any and all of which are eager to assist us in our local efforts for fire safety. Then there are the National Association of Credit Men and the Building Officials Conference; the former one hundred per cent behind our field service as in all other of our activities, the latter stimulating the local building department officials to co-operate. Altogether there is developing behind our present effort a power and influence that should enable us to begin at once to put a very considerable crimp in the shameful fire waste statistics of our country.

* * * * *

The Fire Marshals and the Fire Chiefs. The Fire Marshals' Association of North America and the International Association of Fire Engineers are not organizations of sufficient coherence to function very effectively in national efforts. To do this they would require to establish and maintain permanent offices with a trained corps of employees; to publish periodicals, and focus their power on objectives beyond the immediate interest of their members. Such activities their revenues would not permit even should their inclinations lie that way, which they do not. The great potential strength of these organizations lies in what at their annual meetings they may agree to go home and do in their own states and cities. Thus their individual local efforts added into a sum may represent and have the value of a national achievement. In responding favorably to the invitation of the American Water Works

Association to unite with that body and the N. F. P. A. in a campaign for fire safety in individual cities through the establishment of cabinets or committees with the fire chief as the central figure, the International Association of Fire Engineers has very shrewdly recognized its line of greatest effectiveness and it will be surprising if the ensuing annual meetings of that body do not show a life and vitality that have not always been present at past conventions. The individual fire marshals have of course a wider area for their operations. What the fire chief would do in his city the fire marshal would do in his state, that is to say the fire marshal whose interest does not lie wholly in the pursuit of firebugs, but who desires to see the fire waste of his state decline. It would appear that to achieve this result he could not do better than to put the full force of his office behind the individual efforts of the chiefs. The statistics of the state are the statistics of the cities added together, so that every fire avoided in the cities is one avoided in the state. The fire marshal may travel about at state expense and should he desire to do so each one might be an effective "field secretary" himself, stimulating local fire prevention efforts, encouraging and assisting the fire chief by using the influence of the state in creating about him the effective and influential body of men he desires. Such co-operative effort would be likely to bring about sympathetic relations between the state and city officials which in many states do not now exist, and result from year to year in a better showing for both offices.

* * * * *

A Joint Committee in Canada.

Canada, like the United States, has up to this time largely confined her fire prevention work to speeches and printed matter. Now, however, there are good prospects of intensive work in the Dominion of the sort being attempted in the states. The formation of a joint committee composed of representatives of the Canadian Manufacturers' Association, the Dominion Association of Fire Chiefs, the Canadian Division of the American Water Works Association and the National Fire Protection Association promises a closer attack upon the problem in Canada than has yet been made. The secretary of this new committee, while one of the representatives of the N. F. P. A., is the deputy fire marshal of Ontario, George F. Lewis, who is also secretary of the Canadian Fire Marshals' Association and has therefore a very direct contact in his own office and through his fellow fire marshals with the cities of the Dominion distributed through the various provinces. The plan of attack is the formation of fire chiefs' cabinets, starting in each city with the fire chief and the waterworks engineer as a nucleus and adding to the local body the influential citizens who are willing to advise with the chief in his fire prevention work. The fire marshals and their deputies are to be asked to

serve personally in promoting this form of organization and in encouraging and assisting it after its creation. This plan, if the fire marshals respond to it, will provide the joint committee with an influential field man in each province. The co-operating organizations have appointed first rate men as their representatives on this committee. The committee, the fire chiefs and the fire marshals have an admirable opportunity for team work in reducing the deplorable fire losses of Canada, and the companion forces in the United States will warmly applaud whatever may be accomplished.

* * * * *

Moths, Flames and Editors. The moth and his liking for the flame are proverbial, but it is fortunately not often that we find the moth followed into the flame by the editor—and the editor followed by his readers. Within the past few months the editors of the *American Magazine* and the *Literary Digest,* in their pursuit of the ubiquitous moth, have given advice that is likely to lead many into the flame, in a way that is just as senseless as the moth's suicidal predilection for fire. The innocent victim, insect or human, cannot be blamed, but that the editors could print the items described below is scarcely believable.

The *American Magazine* conservatively chooses spontaneous ignition fires in clothes closets, while the *Literary Digest* prefers the more radical method of carbon bisulphide explosions. The *American Magazine,* in an article "What the Dyer and Cleaner Knows about Your Clothes" prints the following:

> "Before putting away your winter things, wipe out the closet or chest with turpentine. Leave rags that have been saturated with turpentine in the closet all summer; and two or three times during the summer months saturate them anew. The rags should be wrapped in tissue paper . . . ."

The N. F. P. A. Executive Office remonstrated with the *American Magazine* editor, and received a courteous reply, "I am taking this matter up with the author of the article."

The *Literary Digest* perhaps admits no responsibility for material reprinted from other publications, but should not escape responsibility for printing an article describing the process of fumigation with carbon bisulphide, which concludes with the statement: "It is fortunate that this process affords a reliable safe method of freeing furniture from moths in a short time without injury to fabrics or to human life." If going in for advice of this kind it might be suggested that an effective method of eliminating troubles from soot in the furnace is to mix dynamite with the coal! The N. F. P. A. Executive Office made an attempt to run down the source of this pernicious story, and found that it was apparently originally inspired by a manufacturer of a fumigation cabinet designed for use with carbon bisulphide.

The efficiency of moth elimination by either of the methods described above is not questioned, and not wishing to discriminate between the *American Magazine* and the *Literary Digest,* we unhesitatingly say that anyone who conscientiously follows either method will have no more trouble from moths—unless perchance he lives to rebuild the house destroyed as a result of such attempted fumigation.

* * * * *

The Blazing Trail. According to news dispatches from Suffield, Mass., Allan P. Phillips of East Street, who conducts a poultry farm and market garden, has been troubled with woodchucks eating his garden truck this summer. Someone told him to saturate some hay with kerosene, light it and push it down the hole with a wire, so he tried the experiment. He took some dry hay and wired it into a ball, leaving a few feet of wire with which to push the flaming mass deep in the ground, then he saturated the ball with some kerosene, applied a match and started on the first hole of the course. There was a woodchuck in the hole that did not like the fire and smoke, so it came out hastily and in its confusion became entangled in the wire attached to the conflagration. Arriving at the mouth of the hole, Mr. Chuck sighted the Connecticut River gleaming peacefully through the trees and like a flaming comet started for it through a field of well-cured hay.

Every time he crossed a windrow of hay, he started a fire, and by the time the animal had reached the river and plunged into its cooling depths, the hayfield looked like the result of an Indian uprising. Mr. Phillips, the hired help and the neighbors spent an hour subduing the fire and keeping it away from the tobacco sheds.

Years ago a man by the name of Samson tied firebrands to the tails of foxes to destroy his enemies fields, but a woodchuck is evidently just as good if it is young and speedy.

* * * * *

Labor and Upholstery Shop Hazards. Mattress factories and the upholstery departments of furniture factories, since the very beginnings of fire protection, have been regarded as fire breeders. In the past, however, the fire hazards involved have been little appreciated by the public, and least of all by the owners and employees of such factories.

In September, some five hundred employees in the furniture making industry of Greater Boston struck in an effort to better fire hazard and sanitary conditions in their places of employment. The demand was for the abolition of the use of second-hand stuffing. New stuffing material, contained in bales or packages, is far safer than second-hand material, usually supplied in inferior containers, and largely strewn promiscuously about the floor. The sincerity of this demand on the part of labor is

emphasized by the fact that the strike was by both union and non-union men, and that no other issues were at stake—no increase in pay or other changes in working conditions were asked by the strikers.

The strike was successful, and the employers signed contracts stipulating the exclusive use of new stuffing materials.

It is not surprising that the employees should recognize the fire and health menace of second-hand stuffing materials; but that public education should have progressed to the point where the employers recognized the hazards and acceded to the demands of labor for safer working conditions, is evidence that in one instance at least fire prevention efforts have not been without avail.

* * * * *

"Fireproof" Paints. Years ago the notion that any sort of paint coating on wood might make it "fireproof" was exploded. The results of scientific tests and N. F. P. A. committee reports showed that the so called "fireproof" paints have at best only a limited value in retarding ignition of the surfaces which they cover. It is not the intention to intimate that these paints have no value. Any painted surface is somewhat less susceptible to ignition than old unpainted wood. A number of the proprietary paints, and best of all, whitewash, do to an appreciable extent retard ignition by sparks or small flames. The danger, of course, is that the owner will apply a few cans of paint to his wooden fire trap and then self-righteously assert that his is a "fireproof building." Much has been done to educate the public as to the actual value of such coatings, but to a considerable extent the popular belief seems to persist that by the use of some sort of magic formula cheap flammable construction can be made fire-resistive. Perhaps the growing public appreciation of the desirability of fire-resistive construction fosters the demand for some cheap, conscience-satisfying palliative. At any rate the N. F. P. A. Executive Office receives frequent inquiries about such paints. Not long ago one inquirer, not satisfied with the reply that no amount of paint of any kind could make the wooden school building he described a safe place for his children, wrote again asking for a list of manufacturers of "fireproof" paints. The Executive Office, in the course of furnishing information service to members, prides itself on answering all questions within its ability, irrespective of the worthiness of the questions asked. So in answer a list was secured showing over a hundred different manufacturers of "fireproof" paints!

It is of interest to note that a recent series of tests again demonstrates that whitewash is more effective than any of several proprietary "fireproof" paints tested. Sodium silicate is rated next to whitewash by the same tests. Both have the advantage of cheapness.

"SHAKE!"

(Copyright 1924 by Star Company)

—Chicago Herald and Examiner.

The Story of Indianapolis.

The story of Indianapolis is the story of a city with a bad fire record which took itself in hand for the redemption of that record and in accomplishing that redemption developed a civic morale which bids fair, as far as fire safety is concerned, to give it a permanent excellence of standing among its sister cities of the nation. The fire losses of Indianapolis for the five year period ending with 1920 were as bad as they could be and leave the city on the map. The combination of the wooden shingle and Indiana coal kept the fire department so continuously on the run in the residence districts as to cripple it materially in its fire defense of the mercantile and factory sections. The peak of the wooden shingle fire record was reached on a certain windy day on which there were 68 fires on such roofs in the city. Accumulations of burnable rubbish were also adding their quota of alarms in all sections and the net result as recorded by the fire insurance companies doing business in Indianapolis was a fire loss of 76 per cent of the premiums written for the five years ending with 1920.

The business interests of the city facing this unflattering record realized that it could not continue and the Indianapolis Chamber of Commerce undertook to develop ways and means to check the daily burnings and to limit their disastrous effects. It was obvious that the wooden shingle roof must be abolished. While this sort of roof covering was bad enough as to fire hazard with almost any sort of fuel, in Indianapolis as shown by the daily record it was critically hazardous. To draft legal restrictions was easy, but to pass and enforce such measures successfully in advance of an awakened public opinion was another matter. The Chamber of Commerce sensed the fact that a campaign of public education must precede any successful reduction of fire hazards in Indianapolis. A mere committee of the Chamber would not answer; a group must be interested whose members would carry weight with all classes and conditions of men. A Fire Prevention Committee was therefore organized by the Chamber, composed of influential men and women from all sections and all walks of life. Public education was the first obligation; the people must be brought to recognize the gravity of local conditions. The committee collected and discussed all the various forms of publicity in use by other cities, selected from these the forms that seemed most effective and involved the least waste of effort and material, and then proceeded to evolve some ideas of its own. At a busy down-town corner a huge blackboard was erected and on this was chalked up the daily fire record with

the causes and a comparison with previous years. The crowds surging by day after day studied these records, discussed and commented on them, and in a few weeks the opposition to proposed legislation abolishing the wooden shingle was dissipated and the measure went through the city council. Other agencies of course aided in the creation of an attitude of public consent to this restriction; the newspapers helped generously, and Fire Chief O'Brien adopted the clever and effective educational method of standing up in his automobile as soon as a shingle roof fire was under control in the residence districts and lecturing on the hazards of flammable roof coverings to the crowd of assembled neighbors and passers-by. Meanwhile if the fire had occurred at an hour when the schools were not in session, the boy scouts, after patrolling the neighborhood to locate and report to the chief any fires on other roofs ignited by sparks, would distribute educational bulletins on domestic fire hazards.

The city ordinance required fire-resistive coverings on all new roofs in the city with certain provisions relative to wooden shingle roofs requiring repair. This was the beginning of a new status which with time would abolish the flammable roof. However, for the present the fire department would continue to run to shingle roof fires and the conflagration hazard in the residence district would still persist. The Fire Prevention Committee desired to make more rapid progress in the elimination of this hazard. It called into conference the roofing companies of the city, who responded to the appeal for co-operation by reducing their prices on fire-resistive roofing material to a narrow margin of profit and by granting to citizens, where desired, from two to six months' time in paying for new roofs. Following the publication of this agreement the roofing concerns were so overwhelmed with business that they could hardly cope with it. Since the beginning of the campaign and the passage of the city ordinance, between 12,000 and 15,000 wooden shingle roofs have been replaced by fire-resistive roofs, which, with the fire-resistive roofs of the new houses, now so dominate the residence districts as materially to reduce the danger of conflagration, and to radically cut down the fire department calls to fires on roofs. This fine accomplishment, which will soon effectively abolish the sweeping fire hazard in the residence districts of Indianapolis, is alone worth the efforts of the committee. That the campaign of education is effective over and above the legal persuasion of the shingle roof ordinance is indicated by the fact that outside the city limits, where the ordinance does not apply, fire-resistive roof covering is also being generally used, and thus the condition of a cordon of flammable conflagration-breeding structures about the fire limits, which is so common to the average city, is not likely to be created in Indianapolis.

When the campaign was started, it was not expected that there would be any great reduction in number of fires until the program had been

under active headway for some time. The roofing replacement, however, has gone forward faster than anticipated, and it now appears that a material decrease in the number of alarms can be expected within the next year or two. Already there has been a reduction in the number of fires caused by sparks on roofs, from 1798 in 1922 to 1488 in 1923.

Contemporaneously with this special drive for the abolition of the wooden shingle hazard, now covering a period of several years, has gone along the persistent campaign of general public education inaugurated and maintained by the committee. Courses of public instruction in fire prevention have been given in large local auditoriums in which the leading fire prevention experts of America have spoken to audiences of one thousand people; all the motion pictures on this subject wherever produced have been obtained and displayed in Indianapolis; the teaching of fire prevention is a regular feature of public school education; window displays of an instructive character are common in and outside of fire prevention week periods; the Indianapolis press gives constant attention to ideas of fire safety; addresses are made and literature distributed systematically and effectively with particular avoidance of common-place spectacular features and the waste of funds and effort in directions not recognized as effective. The fire stations themselves have been used as civic centers in which luncheons have been served to local gatherings and addresses delivered by firemen to the neighbors who have crowded to these functions. Common sense advice on domestic fire hazards is given at these neighborhood meetings both in spoken and in printed form. The Indianapolis firemen have greatly increased their own knowledge and personal efficiency through these educational activities in the department, some of them developing into forceful and effective speakers. The morale of the department has thus been raised to an exceptionally high standard.

The establishment of a fire college and drill school in the department immediately began to improve the physical character of the firemen. The drills were supervised by a member of the department who had been sent to the fire college of the New York Fire Department for training, and all the necessary equipment, such as a drill tower, sectional fire hydrants, an automatic sprinkler installation, etc., was provided. All new men taken into the department subsequent to the establishment of this school have been and are required to take the course of training and pass the examinations for efficiency, courage and skill that are imposed before official appointment. The old type of applicant who sought appointment through political influence without being fit for the job has disappeared. Occasionally one of them approaches the drill yard, looks through the gate at the firemen scaling the sheer walls of the tower and jumping nimbly from the high windows into the life nets, and passes on in search of a less strenuous job. This drill school has not served the Indianapolis depart-

ment alone; fire chiefs and firemen from other towns of Indiana have utilized its facilities.

The Indianapolis Fire Prevention Committee was among the first to seize upon and make effective the idea of the fire chief's cabinet, which has since been developed and maintained at a high pitch of local influence. The Committee needed no extended arguments to recognize the fact that the fire chief of a city is the logical administrator of fire safety measures. He is the man selected and paid by the citizens to safeguard their lives and property from fire. "If," said Chief O'Brien, "he is not competent to meet this high responsibility, nor willing to direct all his life and work to this end, he should give place to someone who is." Fire prevention committees may come and go, wax and wane, dependent upon the persons who constitute them and the duration of their interest, but the fire chief's interest and obligation are continuous; he is always on the job; it is his business. A group or cabinet of influential citizens gathered about a fire chief can be made to function continuously, for it is his own creation, a body from which the members may drop out or to which new ones may be added as their interest or ability to serve may be made manifest. They are not assembled to advise the chief how to run his department; that is the job which obviously is his own. The sole function of the cabinet is fire prevention, a body ordained to act as the chief's advisors in putting forward before the citizens the larger plans of city fire safety which the chief alone cannot make effective and which if not adopted may render all his fire fighting skill of no avail.

Chief O'Brien of Indianapolis had the imagination to see the value of such a cabinet, how it would fortify his powers and dignify and strengthen his department in every way; and the past few years have demonstrated the correctness of his judgment. Throughout the entire fire prevention program the dominating thought has been to co-operate with the fire chief in providing an efficient public fire service and no step has been taken without counsel with him. The original fire prevention committee now functions as Chief O'Brien's cabinet which he can call together at any time for consideration of matters affecting the fire safety of the city. The Indianapolis experiment has demonstrated that no one considers himself too good or his office too high for co-operation with the chief in advancing the community's safeguards against fire. The personnel of Chief O'Brien's present cabinet is, so far as power and influence are concerned, far and beyond that of any other group in Indianapolis. Following is the list:

Indianapolis Fire Chief's Cabinet.

Hon. Samuel L. Shank, Mayor
E. L. Kingston, Chairman, Board of Public Safety
E. U. Graff, Superintendent of Public Schools
Newman T. Miller, State Fire Marshal

Henry L. Dithmer, President, Indianapolis Chamber of Commerce
E. O. Snethen, President, Federation of Community Civic Clubs
James M. Ogden, Corporation Counsel
Richard Lieber, Director, Department of Conservation, State of Indiana
Frank C. Lingenfelter, City Civil Engineer
Mrs. John T. Wheeler, Chairman, Seventh District Federation of Clubs
Charles E. Coffin, Chairman, Board of Public Works
Earl R. Conder, President of Church Federation
J. J. Fitzgerald, Grain Dealers National Mutual Insurance Co.
E. M. Sellers, Manager, Indiana Inspection Bureau
T. S. McMurray, State Insurance Commissioner
John E. Milnor, C. F. Sayles Company
Mrs. J. B. Kealing
C. L. Kirk, Vice-President, Citizens Gas Company
Jos. L. Hogue, City Controller
W. J. Curran, Superintendent, Indianapolis Salvage Corps
Robert I. Todd, President, Indianapolis Street Railway Company
Chas. H. Smith, President, Parent Teachers Association
L. B. Andrus, Merchants Heat and Light Company
F. C. Jordan, Secretary, Indianapolis Water Company, and Chairman, Fire Prevention Committee
Walter W. Wise, President, City Council
Rt. Rev. Francis H. Gavisk
Fred C. Gardner, President, Employers' Association
Mrs. Brandt T. Steele, President, Woman's Department Club
Mrs. Felix T. McWhirter
O. A. Farthing, President, Credit Men's Association
C. H. Rottger, President, Indiana Bell Telephone Company
Walter C. Marmon, Indianapolis Light & Heat Company
J. Martin Antrim, President, Board of Trade
John R. Welch, President, Real Estate Board
Charles L. Hartman, President, Merchants' Association
Virgil T. Furgason, Chief, Division of Fire Prevention
E. H. Forry, Farmers Trust Company
Sol Kiser, Meyer-Kiser Bank.

It is doubtful if any other municipal activity could attract for intimate identification with it such a distinguished list of citizens as this.

Of course in this cabinet, as in all other organizations of busy and influential people, there are outstanding figures who take time to familiarize themselves with all the details of the work, and bring to its conduct executive competence and a wide knowledge of affairs. Such a man is Frank C. Jordan, Secretary of the Indianapolis Water Company, who is Chairman of the Fire Prevention Committee of the Chamber of Commerce and with the President of the Chamber, Mr. Dithmer, represents that body in the chief's cabinet. Mr. Jordan has long been an active member of the National Fire Protection Association, and his recent election as President of the American Water Works Association testifies to the recognition of his abilities outside the city of his residence. "Without Frank Jordan," says Chief O'Brien, "we never could have permanently awakened Indianapolis. His faith has never wavered, his devotion never waned, his persistence never slackened. He is of the breed of workers who do not recognize any power in obstacles to a good cause."

Mr. Jordan's own company appreciates his public service and has

responded to the call of the fire prevention campaign by an attempt to furnish the city with a fire extinguishing water service second to none in the country. In the course of the campaign a careful survey was made of the city's fire extinguishing facilities. Tests were made to determine the amounts of water available and which could or should be made available. In consequence of this survey new equipment was added to the fire department, and the Indianapolis Water Company, since January 1, 1923, has installed 279,639 feet of new water mains, of which 89,470 feet have been in sizes of 12 to 30 inches. Large fire hydrants to the number of 393 have been installed on these lines, equipped with 2½ inch hose connections and one steamer connection; 236 smaller fire hydrants on existing lines have been replaced with the large type fire hydrants. The installation of these feeder mains and large hydrants has greatly strengthened the city's fire protection service, and further betterments are contemplated by the company. Another service of the water company, which might be copied to advantage by other cities, is the assembling, through the cooperation of Chief O'Brien, of all the fire department officers and subofficers for a study of the water company's feeder main maps under the direction of the water works engineers. Many a city has paid a heavy price through lack of knowledge by its firemen of the size of the mains to which pumpers have been confidently attached. The promotion of a more intelligent and sympathetic relation between the fire and water departments of all the cities of the United States and Canada is the object of the new joint committee established by the American Water Works Association, the International Association of Fire Engineers and the National Fire Protection Association.

The awakening of Indianapolis to the importance of fire safety and the consequent public interest in and appreciation of the agencies of that safety has had a salutary effect upon the fire department itself. The morale, discipline and fine spirit of the firemen are subjects of civic pride. The firemen feel that they are publicly recognized as trusted units in a respected city service and respond with the best that is in them. It is not surprising, therefore, that the enthusiasm for fire prevention inside and outside the fire department results in effective inspection work and ready compliance by citizens with fire department recommendations. Under Chief O'Brien is organized the Division of Fire Prevention of which Virgil T. Furgason is the capable and enthusiastic chief. An average of 60,000 inspections per year are made and when for any reason, such as sickness or leave of absence, the full force of the inspection division is not operating, Chief O'Brien details additional firemen for special limited service. This rigid inspection, resulting in an intimate knowledge by the fire department of all housekeeping conditions in the commercial establishments of the city, as well as the quantity and char-

acter of their stocks, has driven the fire-bug from Indianapolis. Captain W. J. Curran of the Salvage Corps is authority for the statement that but one fire has occurred in the past two years toward which the finger of suspicion might be pointed and the loss in this fire was but $3,000. Compared to Detroit, in which fire losses from incendiarism have in the past three years aggregated $1,000,000 and over, the effect of the Indianapolis campaign upon public morale alone is striking.

An important factor in the success of the campaign has been the co-operation of the city government. Mayor Samuel L. Shank has delivered fire prevention addresses, wielded a broom in the clean-up campaigns, and in other ways has publicly indicated his interest in the movement.

It is not usual for the city governments themselves to vote money for fire prevention education, funds for this object being commonly raised by citizens' subscriptions. The city government of Indianapolis, however, has been so impressed by the value of the local effort that the city council has made appropriations of public funds to advance educational work, and has passed without unnecessary delay all reasonable measures recommended by Chief O'Brien after consultation with his cabinet. When the suggestion of a city appropriation for fire prevention education was first made all members of the council did not favor it. Captain Curran encountered one of them on the street one day opposite a vacant tract on which had stood an industrial building housing fifty going concerns. The total taxable value of the building and its industries was considerably over $2,000,000. Fire totally destroyed the building which was never rebuilt. The removal of this property from the Indianapolis tax duplicates deprived the city year after year of the revenues previously derived from it and the councilman finally agreed with Captain Curran that the city itself had an interest in fire defense and if fire prevention education could prevent one fire like this even in the course of a number of years, Indianapolis would be well repaid for the cost of the effort.

Having gotten the wooden shingle hazard in a fair way of control, the influence of the large and increasing number of fire-resistive roofs was cutting down steadily the abnormal fire department runs to roof fires; attention was turned to the hazards of the big outlying industries upon which in a measure the city is dependent for its prosperity. The financial outlay necessary for the adequate fire protection of factories being an item of greater importance than in the case of residence protection, Chief O'Brien did not make sufficiently rapid headway in the protection of this sort of property to register the per capita reduction in the fire waste of Indianapolis the savings in residence and mercantile fires would have otherwise shown. Several disastrous fires in these improperly safeguarded industrials have defeated the coveted and expected radical reduction in aggregate losses. With the co-operation of the local laundrymen's

association every laundry in Indianapolis has been equipped with automatic sprinklers, and this most valuable form of fire protection is now being rapidly adopted by the industrial plants. In one large factory unprotected by sprinklers there was a dip tank surrounded by a wooden partition almost in the center of the property. The owners had agreed to remove and safeguard it but while the preparations were under way the fire occurred, completely destroying the plant and inflicting upon the proprietors of the business a loss over and above insurance of $300,000. One or two fires a year of such magnitude as this obscure the favorable results that actually follow such an effort as Indianapolis has put forth. The above plant has since been rebuilt and equipped with sprinklers, so is no longer the object of concern it was originally.

Throughout the campaign, Chief O'Brien has stressed the importance of calling the fire department at the earliest possible moment. As a result some people have been over-zealous in turning in alarms, and the number of alarms recorded in 1923 shows an increase over the average of the previous years. Of these 4106 alarms, 353 were false, 471 were due to burning flues, 1488 were due to sparks on roofs, and 610 were miscellaneous small fires such as bonfires, etc., these four causes being responsible for a total of 2922 alarms.

When all the big industries are finally safeguarded and the residence districts are free from sweeping fire danger, the congested down-town high value district remains with its insufficient fire stops and large number of old wood-joisted buildings. Possibilities of high fire losses here exist. Chief O'Brien has relied so far on his rigid inspections, resulting in such good housekeeping that in the past two years there have been but two 2-alarm fires down-town. So now comes the big work of the cabinet in backing its fire chief in his effort to eliminate the sweeping fire hazard in the high value districts. A study of the maps showing down-town building construction is being made with the object of fortifying the openings in buildings through which a conflagration may get under way by the interposition of fire stops vertical and horizontal, and the installation of sprinklers in buildings having such flammable contents as might speedily develop a large fire. A good building code takes care of new structures but seldom is it given the retroactive powers that might eliminate the conflagration conditions that have grown up with time. These corrections must be brought about by the good citizenship of the owners of hazardous properties or the exertion of intelligent public opinion. Indianapolis has now created a civic demand for fire safety of sufficient persuasiveness to make it difficult for the owner of a building which menaces the welfare of the city to decline to safeguard it on request of the fire chief and the distinguished body of men and women in his cabinet who may be convinced that the precautions suggested are necessary for community safety.

Indianapolis has already gone a long way and if she succeeds as she now promises to succeed in the creation of a city that is actually fire safe, in which neither residents nor commercial and industrial business will be apprehensive of the fire disasters that have decimated most other cities, her overtures to attract to her gates men and industries that make for success and prosperity will meet with the rewards that she has so well earned.

Arson: Detroit's Effort at Its Control.

Three years ago arson, the deliberate act of setting fire to property for gain in the collection of insurance, was an especially organized business in Detroit. Where there is a low morale in respect to the individual and collective obligation to control fire hazards; where efforts are not continuous in the cause of fire prevention, there, sooner or later, the firebug will appear. The careless citizen is an unconscious incendiary, and where he is not restrained by intelligent public opinion the conscious incendiary finds a relatively safe and profitable field. For example, in Indianapolis, where the fire prevention consciousness is maintained at a high level by continuous public education, there is almost no incendiarism. There has been but one fire in the past two years where arson was even suspec ed and the loss in this fire was but $3000. In Detroit, during 1921, there were 111 fires of incendiary origin; during 1922 there were 59, and in 1923 there were 30, such fires having thus in three years been cut down from eight or ten to two or three a month. The amount of loss reported as paid by insurance companies on incendiary fires in Detroit in the year 1921 was $755,112.35; in the year 1922, $299,979.38, and in 1923, $210,316.03. The awakening of the city to its responsibilities occurred in 1921 following the public disclosure of the operations of the Morris Coleman gang whose leader confessed that he alone had set 17 fires on a contract basis. This dupe and accomplice, whom the newspapers, following their usual custom of exploiting any kind of success, admiringly called the "arson king," is now in the state penitentiary at Marquette and his organization of 38 confederates dissipated, presumably into individual operators.

The intelligent manner in which the police and fire departments of Detroit planned to co-operate in the control of arson as soon as they were convinced that an awakened public opinion would approve of and sustain their efforts deserves to be recorded.

On November 1st, in the year 1921, Commissioner of Police Frank H. Croul appointed detectives Howard L. Seiler and George W. Smith

as members of an arson squad. These men were relieved from other work in the police department and assigned to the investigation of fires exclusively. The men were given a small office in which they might interrogate witnesses.

The fire commissioners of Detroit issued instructions to all of the battalion chiefs of the fire department to make a close survey of every fire to ascertain whether the origin was incendiary, suspicious, or purely accidental. The fire department was notified in the event of suspicion as to the origin of any fire, or in the event that there was any physical evidence to show that the loss was incendiary, that the police department might in turn be immediately informed.

Whenever a battalion chief calls the police department, and notifies them that a fire is of suspicious origin, whether it be night or day, uniformed policemen are sent to the scene to take entire charge of the building to preserve the evidence and to keep any one from entering the building until after the arrival of the members of the arson squad. On the arrival of Smith and Seiler, the watch may be maintained or it may be discontinued, according to the circumstances, but detectives Smith and Seiler at once begin a thorough investigation. If there is any physical evidence, or if photographs are necessary in order to show exact conditions, the city photographer is called and the premises are photographed. If necessary, the city engineer is called to make a drawing. Witnesses are taken to the rooms of the arson squad and interrogated; the testimony is transcribed; and, if it is deemed that a case has been developed, the detectives of the arson squad cause the arrest of the suspect, who is given a preliminary hearing and either held for trial or discharged. All of the physical evidence is removed to police headquarters and sealed and marked for exhibit at the trial. The district attorney is furnished with a copy of the report and copies of photographs. All physical evidence is brought into court by the detectives so that it may be introduced as exhibits, and these detectives follow the case until its final determination.

The two detectives of the police department who were appointed as the arson squad and who still constitute it found their new work so intriguing that within the first month of their service they began to respond to all second and third alarms of the fire department which came in between eight at night and eight in the morning without waiting for a special call from the firemen, having soon learned that the fire bug operates preferably and more advantageously at night. To the zeal, imagination and resourcefulness of these men in tackling and continuing their new job is due the interesting success they have registered in it and the enviable reputation they have won both in the ranks of the police

and the opinion of the people of Detroit who are interested in such matters. Since the beginning of their service under the Detroit plan eleven convictions have been obtained for the crime of arson committed in Detroit.

A study of the statistics given in the reports of the arson squad to Fire Marshal G. S. Goldwater shows that incendiarism is not confined to the proverbial small clothing store.

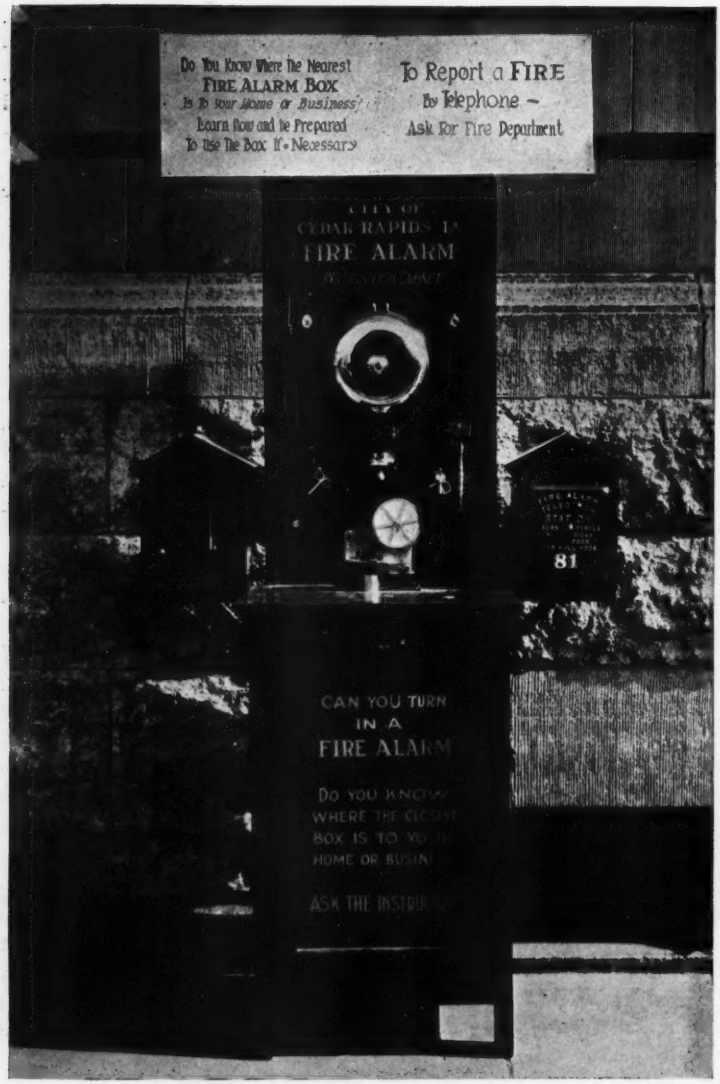
The fifty-nine incendiary fires shown in the report for 1922 are classified as follows:

Dwellings	28	Hardware stores	1
Grocery stores	5	Wholesale fruit market	1
Dry-goods stores	4	Bakery	1
Factories	4	Lumber yard	1
Gents' furnishing stores	3	Junk shop	1
Pool rooms	3	Barn	1
Garages	2	Church	1
Automobiles	2	Vacant building	1

Forty of the above fires were incendiary from the inside, that is, set by the owner or occupant of the property or by a "torch" procured by one or both of them. The remaining nineteen were incendiary from the outside, or set by some person not connected with the burned property, for revenge or some other such cause.

The thirty incendiary fires of 1923 were similarly distributed as to the kind of properties or business involved. Seventeen were set from the inside and thirteen from outside the burned building.

The simplicity and economy of this Detroit plan of co-operation of the police and fire departments in the work of discouraging arson should appeal to the officials of all the cities of the country that are plagued by this hideous sort of crook. "The fire bug," says Detroit fire marshal Goldwater, "is the meanest criminal of all. We have convicted men who for hope of a most beggarly financial gain have set fire to a flat with families having small children sleeping in apartments above." Beside the obvious inhumanity of these crimes their dread economic significance is that any one of such fires may burn an entire city as the Chelsea conflagration is believed to have been set by the keeper of a rag storage shop to realize on his insurance policies. Such fires are frequently set at chosen moments when the fire department is fighting fires elsewhere. Every city owes it to itself and to the country to move positively to stamp out this anti-social pest the dire possibilities of whose crimes are so far beyond the imagination of the contemptible culprits whose cupidity incites them.



Courtesy C. J. Stewart (Member N. F. P. A.).

Fire Alarm Demonstration Panel used in Cedar Rapids, Iowa. This has been displayed at all the school buildings, and during Fire Prevention Week was placed at the busiest street corner in the city. A member of the fire department gave demonstrations and distributed cards showing the location of fire alarm boxes.

Indirect Taxation.

An Example of its Operation.

By H. A. Smith.*

Indirect taxation is a method of getting the most feathers with the least squawking.
—Quesnay.

In addition to the usual corporation tax, there are taxes levied upon insurance companies ostensibly for the purpose of supporting the state insurance departments, the fire marshal departments and, locally, to contribute to the maintenance of fire departments or their pension funds. These taxes are based upon premiums received and are readily collected, hence their popularity with the authorities who seek to enlarge the tax revenue year after year, in order to satisfy their insatiable appetite for expenditure.

It is obvious that the insurance companies must allow for taxes in their premiums so that the people who insure their property pay the bill. It cannot be paid by anyone else. It is a truism that the ultimate cost of anything has to be paid by the final consumer. In the case of theatre tickets and many articles of merchandise, the tax is added by the seller at the time the purchase is made, whereas in fire insurance the tax is made a part of the premium, but it is none the less real.

The states collect through the insurance departments millions of dollars annually. A recent compilation of the Chamber of Commerce of the United States shows that for the year 1922 the amount received by the states for licenses, taxes and fees from insurance companies totaled approximately $45,000,000, and only 4.8% of this vast sum was used to defray the expenses of the insurance departments, the balance being turned over to the general state fund and disbursed for the support of other branches of the state government. In every one of thirteen states the surplus thus collected exceeded $1,000,000 and in some states it is found that insurance is paying at least one-eighth of all state taxes and revenues. In 1923, the Insurance Department of Illinois collected $3,594,651 from the insurance companies and in addition, $3,254,300 under the corporation privilege tax. The cost of insurance supervision amounted to only $113,401 and the balance went into the state treasury as an indirect tax upon the provident citizens who insured their lives and property and had already paid their full share of taxes in common with other citizens.

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*President, National Board of Fire Underwriters.

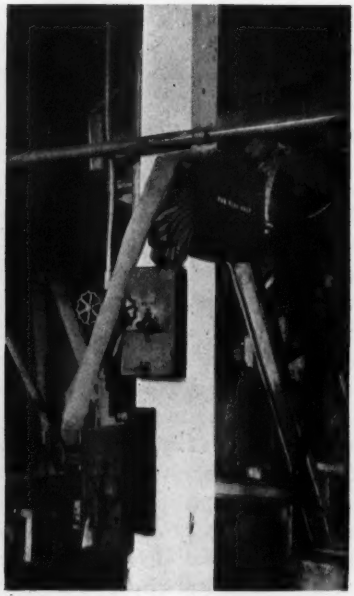
What the Inspector Finds.

Photographs by Blake Darling.

(Member N. F. P. A.)

The number of things as they should not be which are found by the fire inspector as soon as he departs from properties of the highest class, and often even in the best maintained plants, is amazing to the layman. The photographs reproduced on the following pages represent typical hazardous conditions, all too commonly found, that make the work of the inspector necessary. These pictures are of interest as showing the sort of conditions which the inspector has to correct. These are some of the more obvious faults that the property owner should promptly recognize when they are called to his attention. Pages might be written about the conditions shown by each one of these photographs, but the pictures will speak for themselves.

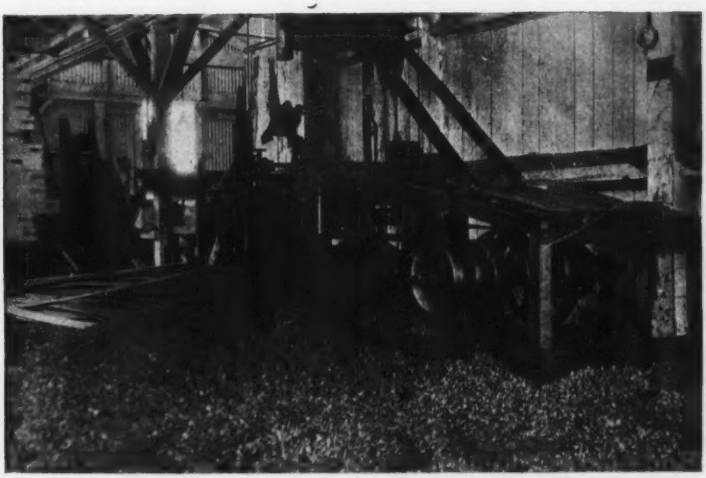
Imagine trying to run this hose out in a hurry in case of fire!



Among several criticisms of this layout, it may be noted that the nozzle is at the bottom of the pile of hose.

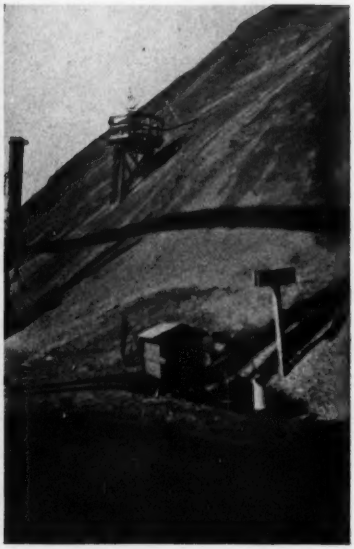
An uncovered barrel of rubbish, containing oil soaked material, placed directly under a stairway.

Defective wiring from starting box (on column) to motor (overhead at right).



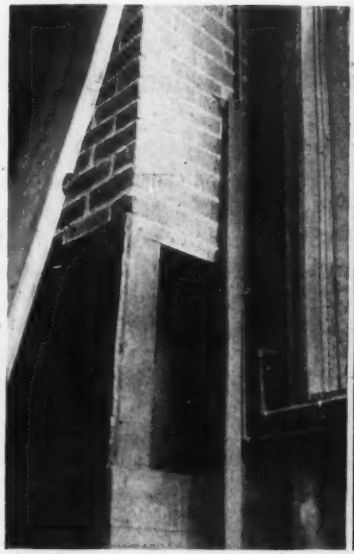
No blower system or other method of collecting shavings from this planer.

What chance has this sprinkler head? It is well wrapped in burlap.



A monitor nozzle and hydrant (in foreground) over run by a sawdust pile. Not much value in case of fire.

A live fuse block and snarled wiring on the floor.



A chimney on a wooden base. Fire occurred here the day after this picture was taken. It was extinguished by sprinklers.

A paper light shade used on an incandescent bulb. The paper had already begun to char when this picture was taken.

Drums of calcium carbide stored under a leaky hose (in center background). All set for trouble.

Fire Prevention in Oil Properties.

By Frank A. Epps.*

(Member N. F. P. A.)

Statistical evidence tells us that lightning is the cause of greater fire loss to the oil industry than all other fire causes put together. To understand lightning fire prevention, it is first necessary to consider the fundamental conditions which arise in lightning fires. A wooden or non-gas tight tank roof is almost invariably a preliminary condition to oil tank ignition by lightning. There are several theories regarding the ignition of wooden roofed tanks.

Undoubtedly there are a number of "direct hits." Experiments made by the General Electric Co. indicate that a tall object will only draw the direct hits that would otherwise fall within a zone whose radius is four times the height of the object. Thus, a tank 30 feet high will probably receive discharges that would otherwise strike the earth within a radius of 120 feet. The tank itself, even though highly conductive to electricity, thus does not draw direct hits from lightning to any appreciable extent.

Fires Caused Indirectly.

The evidence at hand shows that a large proportion of tank fires attributed to lightning are caused in an indirect manner. It is commonly agreed that a column of gas vapor ascends from such tanks at least several hundred feet into the atmosphere. Lightning when flashing through this vapor zone is presumed to cause a flash-back to the tank. It is highly improbable however that a tank would be ignited in this manner.

In the first place, the vapor from crude oil and gasoline is largely pentane and hexane, with perhaps smaller portions of propane and butane. All of those gases are from one and one-half to three times heavier than air, and it is not probable that they would rise to any extent. Secondly, a thunder storm not accompanied by more or less wind is unusual. In fact, the wind is part of the storm itself. Any wind or breeze would very rapidly dissipate the column of gases which might be hovering above the tank. Thirdly, even assuming the gases would rise, it is not probable that a mixture rich enough to propagate flame would extend several hundred feet into the atmosphere. But even so, the thunder cloud is usually from 2000 to 5000 feet above the earth; this being true, of what account would be a column of vapor a few hundred feet high? It is much more

* Manager, Fire Protection Department, Tide Water Oil Co. This article consists of extracts from an address before the Petroleum Section of the National Safety Council, September 30, 1924, as reported in National Petroleum News.

probable that the lightning will strike the ground in the vicinity of the tank, and the heavy vapors trailing along the ground in a rich enough mixture will flash-back to the tank itself. But here again the wind and breeze serve to dissipate and diffuse the vapors quickly.

Ignition by Induced Charges.

In all probability ignition takes place through what is known as an "induced charge." On a wooden roofed tank covered with sheet iron, the respective sheets not being well bonded together, electricity in rushing back to the ground jumps over a joint between two sheets not in electrical contact, and produces a spark. This spark is produced right where a rich mixture of gas exists and it need only be a few hundredths of an inch long to fire the contents of the tank. This is, in all probability, the true explanation for the ignition of so many wooden roofed tanks.

At first thought, it is remarkable how few steel roofed tanks are ignited by lightning. Occasionally, we hear of one. Certainly the steel roofed tank is not less subject to being struck by a direct hit than a wooden roofed tank. Undoubtedly lightning actually strikes a great many steel roofed tanks and we hear nothing about it. The discharge is immediately conducted to the ground by the steel roof and the shell of the tank. If the tank has no holes in it, that is, if the hatches are closed and the vent is properly protected with a fire screen, an all steel tank is really a safe proposition. Experiments demonstrate that it is impossible for a spark to be produced within such a container by any external electrical manifestation.

In the opinion of the writer every steel roofed tank fire caused by lightning can be traced directly back to an open gauge hatch, open manhole, defective vent screen or other non-gas-tight condition in which vapor was ignited outside and flashed back to the interior of the tank. It is impossible to set fire to an all-steel gas-tight tank by lightning, and in one case lightning was seen to strike such a tank and no ignition resulted therefrom. To prevent tank fires from lightning it is only necessary to provide gas-tight all-steel construction and supply reasonable maintenance.

Another cause of tank fires is exposure, but here also the wooden roof is the primary evil. The gas-tight, steel-roofed tank will withstand very severe conditions of prolonged exposure. Instances can be cited where such tanks have been surrounded for hours by blazing seas of oil, and except for the loss of paint and distillation of some oil, there has been no damage. Under such conditions a gas-tight tank will act like a large still, and the vapors produced will burn from the vents like huge torches.

It has been experimentally demonstrated that a spray of falling oil under certain conditions, could produce extraordinary electrical discharges —sparks several feet long. This is a rare source of fire. It is a hazard,

however, which may be removed by merely submerging all connections which discharge oil into the tank. The "over-shot" connection is a serious offender as regards evaporation loss besides being a fire hazard.

Few Fires Caused by Carelessness.

It is remarkable how few tank fires are caused directly by carelessness. Only once in a great while do we hear of a tank fire being caused by the match or smoking hazard. Occasionally gross carelessness with welding torches is the fire cause. In one instance an employee cut into an overhead run-down line with a welding torch about 200 feet away from the run-down tank. Fire flashed back through the pipe and that ended the career of that tank.

One classification of tank fires in particular has been of considerable interest during the past year. Because of lack of evidence it seems proper to classify these fires as of unknown cause. It is possible that some manifestation of static electricity may be the cause in certain cases, but in most of these cases nothing that we know about static and the condition under which it is produced, would apply. It may be that spontaneous ignition is the answer.

In tanks containing cracked distillates, or crudes of high sulphur content, there is a considerable formation of sulphur deposit on the underside of the tank roofs. This material contains free sulphur, organic sulphides, iron sulphide and iron oxide. It is definitely known that iron sulphide when freshly formed is pyrophoric, that is, it will greedily absorb oxygen until it becomes heated to the point of incandescence.

The gases given off from cracked distillates and high sulphur crudes contain hydrogen sulphide and organic sulphides. It is probable that these gases react with the bare iron, or iron rust incrustation on the inside of the tank to the extent of producing, under certain conditions, a considerable amount of iron sulphide. It is then supposed that this material absorbs oxygen and reaches a glowing temperature, at which temperature it may burst into flame and ignite the explosive vapors in the tank. The fact remains that tanks are set afire now and then for no reason whatever except that which might be explained by this information.

This spontaneous ignition probably cannot be effectively prevented. Fortunately it does not happen often. The only remedy known is regular cleaning, scraping, and painting of the interior of tank roofs and structural members inside of tanks where this formation occurs.

There is one detail of tank construction that has a close bearing on fire prevention. Vent screens as usually installed and maintained are quite ineffective as flame arrestors. Unless a systematic method of inspection of vent screens is pursued, it is probable that a large percentage of the vent screens at any location will be found to be clogged or corroded. In some locations, particularly on tanks containing sour distillates, it is

necessary to renew the vent screens as often as once a month. A monthly inspection should be maintained on the vent screens, and where gases coming from certain grades of oil are particularly corrosive, this inspection should be made at least every two weeks.

Metal vent screens will arrest flame only by reason of their ability to conduct the heat very rapidly to adjacent solid metal parts, thereby preventing the formation of ignition temperature in the other side of the wire screening. If the distance from the central part of the wire screen to solid metal is too great, a single thickness of gauze will not serve, but a double or triple thickness is required. Beyond certain dimensions even a triple thickness of wire screening is unsatisfactory. In order to provide enough venting area and still have the screen dimensions suitable, it is necessary that a number of small 2 in. diameter screens be provided or that the wire gauze screen be clamped between a grill work of heavy metal and that the ports in the grill work should not exceed the area of a 2 in. pipe.

How to Fight Oil Tank Fires.

After a tank fire starts there are two methods of fighting it, the first is with steam and the second with foam. Steam as it is normally applied is not effective unless the roof remains on the tank, which it usually does not. Tank fires usually start with an explosion, and then off comes the roof. In such cases if steam is applied through one of several pipes at the shell of the tank it is absolutely ineffective. Steam is of value, however, in preventing the ignition of exposed tanks nearby.

To extinguish the average oil tank fire there is only one agent which is tried and proven. That is foam. There have been quite a few failures of so-called foam systems, but I do not know of a single instance where a foam system, designed in accordance with accepted standards, maintained in proper condition, and operated with fair judgment, has failed to extinguish a tank fire.

Other methods of handling oil tank fires have been and are being developed, such as the use of water, carbon dioxide, and carbon tetrachloride. These methods are still in the development stage. They do not have any record of actual fires extinguished to prove their merit.

Next to tank fires, the most frequent and expensive fires are those which occur in stills. It is not realized usually that of all the fires which occur in oil properties, perhaps 50 per cent of them occur in the distillation process. Most frequently these are small fires and are caused by small oil or vapor leaks. They are extinguished with hand extinguishers, steam jets, water hose, or by "pumping out" the still, with negligible loss. Occasionally, however, something lets go, a still cracks open, a high pressure drum explodes, or an oil line breaks and a conflagration is started.

The least leak, defect or wearing out of any part is almost certain to cause a fire. Only continual inspection and expert operation will prevent still fires.

Fire walls 24 in. to 30 in. high should be provided around every battery of stills as far as practicable. It is usually possible to use the near wall supporting the condenser boxes as part of this surrounding fire wall. This has the double advantage of economy and subdivision of values as it places the condensers outside of the fire wall. To protect the condensers further, and to protect any towers which may be mounted over them, a fire barrier of brick, tile, asbestos board, or sheet steel, (the latter equipped with water sprays), may be erected from the ground up, adjacent to the condensers, all openings in it being protected with standard fire doors. This forms a splendid fire barrier, protects the condensers and towers, and gives advantageous position to those who may subsequently have to fight a fire there.

As far as practicable by means of fire walls, it is further desirable to break up the fire areas in and among the units of any battery of stills so that a flow of hot oil pouring from a break will endanger as few adjoining stills as possible.

Particular attention should be paid to the method of supporting vapor lines, flow lines, charging lines, in fact all oil and vapor lines. Most frequently these pipe lines are carried overhead on unprotected structural steel work. Any severe fire will bring them down in short order, often even before effective fire fighting can be commenced. These oil lines may drain other stills, and the additional fuel added to the blaze may cause it to become uncontrollable. All supports for such lines should be protected with material known to have at least a three-hour fire resistance period.

One of the simplest and most effective ways of handling a serious still fire is quickly to pump out the burning still and those which are menaced. Therefore, the importance as a fire protection measure of having large pumps for this purpose and large pumping-out lines is apparent. But it is essential that the pumping-out valves shall be equipped with remote controls so that they can be operated safely and surely—usually from the back of the condensers. Likewise, to pump out a still, the tar plug, if there is one, must be up. As tar plugs habitually stick it is desirable that the still be run with these plugs in open position, reliance for closure of the pumping-out line being placed on the pumping-out valves which may be in duplicate. Remote control and frequent inspection of the tar plugs should likewise be provided so that they may be operated surely and quickly from a safe position in case of emergency.

Gauge Glass Offenders.

Glass gauge columns are serious offenders. It is most often impossible to use the customary safety ball-check valve for these gauge glasses. The ball checks corrode or coke up and will not operate. Where a gauge column is necessary, a pipe fitted with closely spaced pet cocks is safe, if

in addition, the gauge connections to the still are fitted with well designed lever operated globe valves, the levers being held in open position by a chain and fusible link.

A great many still fires are the result of carelessness and are caused by pumping over when charging, or permitting water to get into the charging stock, thereby causing the still to froth over. Improper inspection or testing of safety and vacuum valves, clogging of traps and run-back lines are all hazards which may be avoided by proper inspection. In high pressure stills, particularly, the importance of inspection is doubly significant.

Measure Thickness of Stills.

It is usual to measure the thickness of the steel in different parts of a high pressure still at regular intervals because the hot oil apparently corrodes the steel until it becomes quite thin. Naturally, since steel is much weaker at the working temperatures of high pressure stills than at ordinary temperatures, this matter must be watched very carefully and worn parts must be replaced before they become dangerously thin, due consideration being taken of the elastic limit of the steel at the working temperatures of the still.

As with tank fires, the most effective medium for handling a serious still fire is foam—applied this time through hose streams. At one very large plant that has had a very successful record in handling still fires, the superintendent says he would not permit a drop of water to be used on such a fire. As the simultaneous application of water and foam will result in the water breaking down the foam it is apparent why this course should be pursued.

The Fire Brigade.

An obviously important factor in dealing with any fire, is the plant fire brigade. No matter how small the plant or station, the men who may be called upon to fight fires should be trained in what to do and how to do it in the emergency of a fire. Where the plant is of sufficient size a definite military type of organization should be formed headed by a fire chief who has good judgment and is a quick thinker, who knows the plant intimately from one end to the other, whose strong personality enables him to dominate such a situation and secure action and co-operation from his men.

Fire prevention, unfortunately, is not an issue which earns money. It may prevent money from being lost, but it does not bring money in—it is negative rather than positive. Work done and money spent toward fire prevention do not aid in paying dividends, except in a negative sense. Consequently, the operating forces of many properties to whom this important matter is delegated, while admitting its importance, very frequently do little in that direction. Production claims their attention. All other matters are secondary—and in this list falls fire prevention.

A few years ago the company with which I am connected organized a fire protection department. To obtain an accurate understanding of the conditions existing at each property, a survey was made of every building, tank, still, agitator, loading rack, etc. All the details of construction, occupancy, internal and external exposures, fire hazards and fire protection were considered. As a result of these surveys, detailed recommendations for the improvement of unsatisfactory conditions were made and submitted to the operating managements, and followed through to a "yes or no" decision.

Regular Inspections.

Since that time re-inspections have been made of each structure covered in the original survey at periods varying from three to twelve months for the purpose of detecting new hazards, and checking up on the former ones.

This department further has collaborated with the engineering and purchasing departments in the development of proper designs and specifications for fire protection materials and installations, thereby making use of the best materials and practices available.

Reports of fires, no matter how small, occurring on our own properties are collected and analyzed. Information and lessons obtained therefrom, which are of value, are distributed to those interested. Educational work is carried on by means of bulletin boards, direct contact, and through the mails.

It is too soon to forecast what will be the ultimate saving to the company through this work. A severe fire may occur tomorrow in spite of our precautions. It may be said, however, that with the removal of many fire causes, with the improvement of structural fire-resistive conditions and fire fighting facilities, and with a keen interest in fire prevention on the part of the operating personnel aroused and kept aroused, our chances of severe loss have been considerably reduced and should continue to grow less as the work further advances, until the limit of improvement is reached—at which time, as with accident prevention, the problem becomes one of maintaining the headway accomplished and preventing retrogression.

In its final analysis, fire protection is a problem of administration and organization. This important work must be properly organized, thoroughly studied, conscientiously executed, and last but not least, inspired by attention from the management if it is to achieve its deserving success.

Water On Oil Fires.

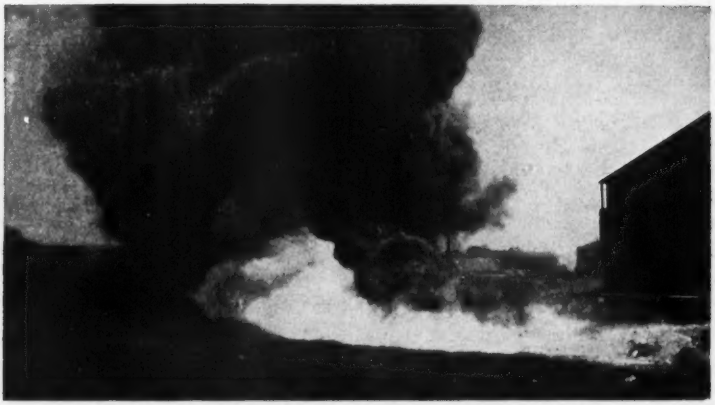
Oil and water do not mix, but, contrary to popular belief, oil fires can under certain conditions be extinguished with water, as is shown by tests recently conducted by the Factory Mutual Laboratories (Member N. F. P. A.). These fire tests, made under conditions simulating those actually obtaining in manufacturing processes, showed that burning asphalt and similar heavy oils can be extinguished by water from automatic sprinklers or hose streams. The tests are reported in the Factory Mutual Record as follows:

Effect of Water on Oil Fires.

Conditions were made to represent oil-quenching tanks, paint and enamel dip-tanks, impregnating-kettles, and other industrial apparatus, involving hazardous liquids in open containers and often heated. Hard

The fire at its height several minutes after ignition. The dense smoke conceals the flames.

asphalt and heavy Mexican fuel-oil, with flash-points of 478° F. and 204° F., respectively, were tried first on the assumption that water would probably extinguish fires in them by cooling the liquids below their flash-point. Four barrels of the asphalt was preheated nearly to the flash-point in a tank of forty square feet area and then ignited. The sprinklers were kept shut off until the asphalt was burning freely over the entire surface, when they were turned on, extinguishing the fire in fifteen seconds. The



A few seconds after applying 1⅛-in. hose stream, showing the steam formed as the heat vaporized the water.

water from the sprinklers falling into the hot asphalt caused a tenacious foam to form on the surface and overflow the sides of the tank.

About a barrel of the asphalt was then drawn from the tank on to the surface of the marsh which surrounds the test house, and an equal amount of fuel oil was added to it. The mixture was ignited on the windward side so that the fire soon spread over the entire area. The illustrations show the fire at its height and the effectiveness of a single 1⅛-in. hose stream, which extinguished the fire in about ten seconds.

The second test was made with the fuel oil alone, as its flash-point of 204° was about the temperature of boiling water, and there was some doubt whether or not the sprinkler water could cool the burning oil below its flash-point. Five barrels of the oil were heated to about 212°, when it began to foam and expand until it overflowed the tank and became ignited by the preheating fire beneath. The whole surface of the oil in the tank and a large area on the floor was ablaze, opening twelve sprinklers, which quickly extinguished the fire in the building. Some of the burning oil had run out of the building on to the surrounding marsh, and a hose stream, which was brought into play, promptly extinguished this fire. Another series of tests was made on forty square feet of lighter oils, including furnace-oil, kerosene and japan varnish, with flash-points of 164° F., 134° F., and 69° F. respectively. Although foam extinguishers would be recommended for tanks of oil of this kind, it was desired to determine the effect of water from automatic sprinklers. The water did not extinguish fires in these lighter oils, even though the heads were spaced five feet apart in each direction, but it did

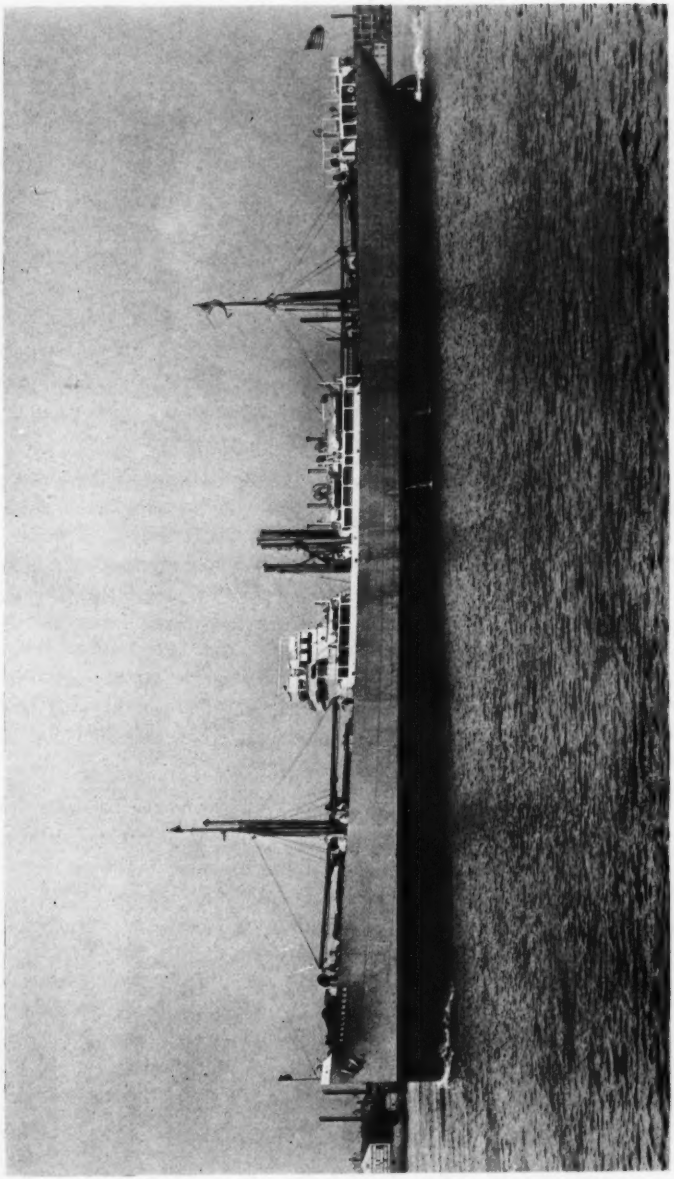
All out ten seconds after turning on hose. Smoke and steam cloud drifting away.

reduce the height of the flames considerably and absorb sufficient heat to keep the building cool and prevent it from being damaged.

Approximately half of the sprinkler water that ordinarily would fall into the tank was turned into steam, the remainder gradually raising the level of the oil in the tank until the burning oil on top of the water drained off through an overflow pipe with which the tank was provided. This not only shortened the duration of the fire, but prevented the oil from floating over the sides of the tank and increasing the area of the fire. The overflow pipe was provided with a trap in which the burning oil was extinguished by being deprived of air as it passed through the trap.

Conclusions.

As a result of these two tests it was evident that the ordinary forms of protection, such as automatic sprinklers and hose streams, would be effective in manufacturing rooms containing asphalts, impregnating compounds, and similar heavy oils having a flash-point above 200° F. For light, thin oils, foam is the best extinguishing agent, but sprinklers are needed in all such cases to protect the building, and do not interfere with the effectiveness of the foam. To prevent the sprinkler water from floating the burning oil over the sides of the tank, a liberal overflow pipe should be provided, leading to the outside of the building and arranged with a trap to extinguish the burning oil. A self-closing, tightly fitting cover for a dip tank is an added advantage where conditions will permit its use.



Motor Ship Challenger, equipped with carbon dioxide fire extinguishing system. (See also illustration page 156.)

Carbon Dioxide in Fire Extinguishing.

By Charles L. Jones.*

At the present time, liquefied carbon dioxide does not rank with the better known fire-extinguishing materials in importance. It is, however, in its infancy, not only as regards the extension of its field of usefulness, but as regards the development of new devices for causing it to extinguish fires effectively.

Liquefied Carbon Dioxide.

Carbon dioxide is a familiar material, as it is a product of the combustion of all types of organic matter. It is a normal constituent of the air we breathe. It is non-poisonous, atmospheres containing up to 5% causing no serious impairment of normal activity, and much higher percentages causing no permanent ill effects.[1] It acts on the human system by stimulating respiration and by reducing the oxygen content of the air with which it is mixed. As a rule, the present application of carbon dioxide to fire extinguishment takes place under conditions that avoid any danger to human life from suffocation. It must be recalled in this connection that tons of carbon dioxide may be produced in the burning of a frame building, so that the addition of carbon dioxide from cylinders only complicates the problem slightly in most cases.

The artificial production of liquefied carbon dioxide in the United States amounts to between fifty and sixty million pounds annually. The bulk of this product is obtained from the combustion of coke and from fermentation in the manufacture of industrial alcohol, and the largest outlet for the product is in the manufacture of soft drinks. The gas ordinarily comes upon the market in steel cylinders containing 20 pounds or 50 pounds, the greater part of which is present in the cylinder in liquid form. Special cylinders and valves may be had in almost any size and for a wide variety of applications.[2]

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[1] Burrell, Robertson, et al., U. S. Bureau of Mines, Bulletin *105*.

[2] For a discussion of the various uses of carbon dioxide, see Canadian Chemistry and Metallurgy, *7* (1923), 172-4 and 205-7; and Chem. and Met., *29* (1923), 103-5.

It is the purpose of the present article to review briefly the progress made in applying carbon dioxide to various fire-extinguishing problems and to point out the future possibilities of this interesting material. The future development of carbon dioxide fire extinguishment should be of great interest because of the freedom from extinguisher damage that attends the use of dry carbon dioxide. A large part of the fire loss, especially in the case of incipient fires, is damage done by water and chemicals. While the writer by no means anticipates the supplanting of chemicals or of water in all fire extinguishing, it is true that on special types of fire to which carbon dioxide can be adapted there is absolutely no damage done by the extinguishing agent itself. In this respect carbon dioxide and inert gases in general are in a class by themselves.

The reasons for the very limited present application of liquefied carbon dioxide to fire extinguishers are three in number, namely:—

(1) Appliances previously procurable have not made the latent heat of the liquid available, and thus were dependent entirely upon gaseous carbon dioxide for cooling effect. In other words, carbon dioxide extinguishers of the past have depended entirely upon smothering effect, and not upon the cooling and quenching effect of carbon dioxide snow, the latent heat of which is approximately 235 B.t.u. per pound.

(2) Until very recently, no satisfactory means of controlling the discharge of carbon dioxide has been available. It has thus been impossible to deliver large quantities of this gas without difficulty from the stoppage of valves and pipes with carbon dioxide snow or ice.

(3) There has been a fear, not without foundation in the past, that the principle of stored pressure would not prove a good one for fire-extinguishing appliances of any kind, on account of the danger of losing the supply of carbon dioxide through leakage.

This is partly offset by the fact that a supply of liquefied carbon dioxide undergoes no deterioration of any kind and may hence be kept indefinitely, provided only that the amount of carbon dioxide available is periodically verified by weighing.

As more experience is accumulated, it is possible to deal with the leakage problem more intelligently. It may be stated at the outset that cylinders filled under the conditions regarded as satisfactory in the carbon dioxide trade will show too high a percentage of "leakers" for satisfactory use in fire extinguishing. By taking special precautions to be certain that each cylinder is free from leakage for some hours or days after it is charged, the percentage of leaky cylinders is reduced to a very low figure. For many special purposes it is possible to eliminate leakage as a consideration by providing a sufficiently large number of cylinders so

that a single leaky cylinder cannot impair the operation of the system. Differences due to variation in valve design deserve mention, and the availability of copper disc closures which take the place of valves is also of importance sometimes in overcoming leakage trouble. One firm uses a tight transparent viscose cap over valves, which warns of leakage by rupturing.

The leakage problem presents a different aspect in different kinds of equipment; for example, the leakage problem in a marine system comprising over 100 cylinders is entirely different from the problem in small hand extinguisher design. It is sufficient to state here that recent developments have made it possible to cope with the problem satisfactorily in the majority of cases, and further progress is to be expected.

Obviously the limitations mentioned above have not applied with equal force to the various special problems of fire protection, and liquefied carbon dioxide has already gained a foothold in certain fields where these considerations are not important. As the limitations are overcome the field of usefulness is broadening.

Certain recent advantages of fundamental character have removed to a large extent these limitations, so that it is now possible to deliver carbon dioxide at rates of flow not previously possible and with a degree of dependability not previously obtained. Before proceeding to a discussion of the present uses and future possibilities of carbon dioxide in fire extinction, it will be well to outline briefly these advances.

(1) When liquefied carbon dioxide is passed from cylinder pressure to atmospheric pressure, the liquid boils, its latent heat of vaporization being supplied by the cooling of the gas and the residual liquid, until the liquid is solidified to a snow. The snow continues to sublime until its vapor pressure becomes equal to atmospheric pressure, after which further sublimation can take place only through the addition of heat from an external source. Its temperature is then —110° F.

In an ordinary steel cylinder standing upright with the valve at the top, the liquid boils *in* the cylinder; and as the temperature of the residual liquid decreases, the rate of flow through the open valve also decreases, and the likelihood of a stoppage or "freeze-up" in the valve is increased. Finally the residual liquid solidifies, and the rate of flow then becomes very small; the considerable cooling effect that might be exerted by the latent heat of the snow in the cylinder is lost, and it takes many hours for heat enough to find its way into the cylinder to evaporate the remaining carbon dioxide snow.

Obviously, the desirable thing to do would be to evaporate the liquid on the fire, rather than in the cylinder. The simplest expedient with this end in view is to invert the cylinders, or fix them at such an angle that

liquid will drain through the valve.[1] Another way of producing the same effect is to install a siphon tube leading from the valve to the bottom of the cylinder. Both of these expedients have been known and used for many years in making carbon dioxide snow in the laboratory, but taken alone they do not make possible satisfactory application of carbon dioxide to fires, because with either scheme trouble is almost sure to be experienced through stoppage of valves and lines with snow and ice.

(2) Another and more recent advance, which makes possible rapid and dependable discharge without stoppage or freeze-up, rests on a very simple theoretical basis. In dealing with the comparatively rapid discharge required in fire extinguishing, heat transfer to the stream of gas from pipes and cylinders may be neglected, and we may assume that the temperature of the carbon dioxide at any point in the system is solely dependent upon the pressure, and that at a given pressure the temperature will be that of the corresponding vapor pressure of carbon dioxide. It is obvious that freezing and stoppage in the valves and pipes can be avoided by keeping the pressure drop sufficiently small, since cooling is due to the liquid boiling, and the liquid boils when its pressure is decreased.

Now fairly good vapor pressure data for carbon dioxide are readily available,[2] and it will be seen that for the range of temperatures from 30° to 80° F., each 100 pounds pressure-drop in transporting carbon dioxide through a system will correspond to a temperature drop of approximately 10° F. Unfortunately, good data on the viscosity of liquid carbon dioxide, and accurate formulas for calculating pressure-drop in transporting the mixture of vapor and liquid are not available, so that the design of complicated systems for transporting the liquid cannot be determined theoretically, but the problem has been solved in practice in two different ways, both of which work satisfactorily. Each scheme has points of superiority in certain types of work, while a successful scheme for extinguishing oil fires on tank ships uses a combination of the two.

(*a*) F. J. H. Rustige[3] first solved the problem by using a large opening valve and a delivery pipe of "substantially uniform passage dimension." When this passage dimension is sufficiently large in relation to the amount of carbon dioxide to be passed through the line, the pressure-drop, and hence the localized cooling effect, are small, which reduces the tendency to freeze up. By their very size, the passages are moreover difficult to clog.

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[1] The writer has described a large application of this kind of discharge to fighting a mine fire. See N. F. P. A. Quarterly, v. *17* (1923), p. 42.

[2] See engineering handbooks, or A. S. R. E. Journal, *8* (1921) 211.

[3] The Lux system, developed originally by Aktiebolaget Lux, Stockholm, Sweden, Cf. U. S. Patent 1,335,395.

Fig. 1. The quick release valve system on M. S. Johnstone. A 90° movement of handles gives simultaneous full opening of all cylinders.

(*b*) The writer has solved the same problem in a different way, by placing a properly shaped orifice at the point of discharge. Obviously, the pressure-drop from the cylinder to the outside atmosphere is a fixed quantity in any given case; and if the orifice is sufficiently small in proportion to the smallest part of the passage leading to it, the larger part of the pressure-drop, and hence the greater part of the refrigerating effect, will take place across the orifice.

In the present state of the art, the size of the orifice must be determined empirically. In an example, a hand extinguisher containing seven pounds of carbon dioxide, having a minimum valve passage ⅛ in. in diameter, and 40 in. of high-pressure flexible metallic hose, will discharge without stoppage if the area of the discharge orifice is 25% of the area of the minimum valve passage. If the resistance of the system leading to the orifice is greater, this ratio must be made smaller in order to keep the cooling effect concentrated at the orifice.

The shape of the orifice is extremely important, because the evaporation at the orifice is instantaneous, and if the intensely cold snow outside the orifice is allowed to brush the orifice material, heat will be conducted away from the high-pressure side of the orifice, and stoppage will result.[1]

(3) A quick puncture type valve has been developed recently by W. H. Freygang, of New York, which makes it possible to discharge any number of cylinders simultaneously, instantaneously, or by remote control.

This assembly has as its new feature a specially shaped cutter of Monel metal which cuts a full circular opening out of a copper disc closure with a 90° movement of the valve handle. An equipment of this kind is shown in Fig. 1.

(4) Regulating equipment of various types has been developed for applying carbon dioxide to other uses, much of which could be applied to special problems in fire protection. Many nice questions of design are involved and further improvement is very likely in many directions. It is not to be supposed that all carbon dioxide discharge problems have

[1] This is illustrated in Electrical World, *83* (1924), 1138.

been solved, but it is conservative to say that if the next ten years sees as much technical progress as the last ten in developing new and improved means of causing carbon dioxide to discharge when, where, and at the rate desired, carbon dioxide will be second only to water in importance as a fire extinguishing agent.

Historical Review.

Apparently the first successful practical application of inert gas of any kind to extinguishing a fire was in 1851, when a mine fire at Clackmannon, Scotland, was extinguished by forcing flue gases into the mouth of the sealed mine.[1] Barber,[2] a lieutenant in the U. S. Navy, seems to have been the first to suggest the use of liquefied carbon dioxide for this purpose, his proposal having especial reference to fires in the holds of vessels.

Since Barber's time several sporadic attempts have been made to apply carbon dioxide to fire extinguishing. These attempts, which have been principally in connection with mine fires and with fires in the holds of vessels, have made little headway until the last few years. The progress of the years up to the World War may be summarized briefly as follows:

1. **Mine Fires.**—Inert gases of various kinds had been applied several times, but with varying success. As a rule gas treatment proved ineffective, but no thorough study of a mine fire from the standpoint of thermal equilibria and combustion engineering had ever been made.

2. **Marine Fires.**—A great deal of work had been done on the development of inert gas fire extinguishing systems for cargo vessels, and a very good review of the field appears in the literature.[3] The types of inert gas apparatus in commercial use in 1913 were as follows:

(1) Liquefied carbon dioxide—Gronwald system installed on 70 vessels.
(2) Sulfur dioxide—Clayton system.
(3) Flue gases from burning coke—Harker system.

It will be noted that the Gronwald system is the only type then using liquefied carbon dioxide. This system made use of external heat to get the carbon dioxide out of the cylinders without stopping up the pipes by freezing. Compared to the apparatus now available, it was crude and ineffective, and it was entirely incapable of producing the high rates of gas discharge characteristic of the Lux system, to be described further on. The Gronwald system is not used in the United States at all to the writer's knowledge. Sulfur dioxide has also fallen into disfavor, and flue gases are giving way to liquefied carbon dioxide, largely because of the compactness and quick operation of the liquefied carbon dioxide system.

3. **Telephone Switchboard Fires.**—The Bell Telephone Co. of Pennsylvania pioneered in applying inert gas to switchboard fires on account of the damage done to the wiring by other types of extinguishers. The hand extinguisher used before 1914, however, had no special provision for pre-

[1] Mines and Minerals, June, *1908*, 505.

[2] American Chemist, *5* (1875), 395.

[3] Transactions of the Institute of Marine Engineers, *24* (1913), 354-423.

venting freezing, and was not sufficiently dependable in its freedom from leakage, uniformity of discharge, or effectiveness on fire to encourage its adoption by other companies. Nevertheless, despite its imperfections, this extinguisher has more than one successfully extinguished fire to its credit, and has been in use until the present improved type was introduced in 1924.

The Bell Telephone Co. also developed a system for discharging carbon dioxide through pipe lines to the inside of the wiring cabinets behind each operating position. This system was developed in Baltimore some years ago but is not now in use.

Extinguishers in Which the Use of Carbon Dioxide is Incidental.

Several fire extinguishers have been developed which use carbon dioxide simply as a source of pressure to expel fire extinguishing liquids. For example, a Canadian concern manufactures equipment in which a calcium chloride solution is expelled from a tank by the pressure obtained from a cylinder of carbon dioxide. A 2½-gallon non-freezing extinguisher of the same general class is manufactured and sold in the United States. Of course chemically generated carbon dioxide also acts as a source of pressure in the familiar soda-and-acid extinguisher, and carbon dioxide plays an important part in the functioning of foam type extinguishers. In all these cases, however, the action of the carbon dioxide is secondary, and they are mentioned here only to illustrate this use of the gas.

Use of Carbon Dioxide as a Primary Fire Extinguishing Agent.

There are two entirely different types of fire to which carbon dioxide may be applied, involving fundamentally different plans of attack. The distinction is based upon the amount of heat that must be dissipated. Thus we have as one extreme the case of the coal mine fire, which may be walled in and treated to minimize the leakage of air to the fire. Such a fire may be under treatment with inert gas for several months, in order to allow time for the heat to be dissipated. At the other extreme we have fires in switchboard wiring, and in flammable liquids in small tanks. If the flame is instantaneously extinguished in fires of this class, the fire is over. In the coal mine, every possibility of air leakage must be carefully considered in order to insure success with carbon dioxide; in the oil fire a properly designed carbon dioxide system functions out of doors with a high wind blowing. It is obvious that with such a variation of conditions to be met, it is dangerous to generalize.

Some recent developments in the application of carbon dioxide to fire extinction are discussed below under the following heads:

I. Applications in which the fire occurs in a space so enclosed that an extinctive atmosphere can be maintained for a definite period of time. In such systems fires involving large amounts of incandescent material can be held in check, and in some cases entirely extinguished. When fires in

spaces of this character are merely flash fires, they may be extinguished without the necessity of thus holding the gas confined.

A. Mine fires.
B. Fires on shipboard, in cargo spaces or engine room.
C. Fires in cellars, warehouses, dust collectors, and the like.
D. Fires in electric generators.

II. Applications in which fire must be extinguished in the open, or in semi-enclosed spaces. Carbon dioxide is applicable to fires in this class only where no large amount of incandescent material is involved. The special field to which it is best suited will appear from an examination of the applications described.

A. First aid extinguishers for electrical fires.
B. First aid extinguishers for general purposes.
C. The Lux system for extinguishing fires on oil tank-ships.

General Considerations.

Certain general considerations bear upon every application of carbon dioxide to fire protection, and determine to a large extent the plan of attack upon any particular problem. The most important general questions which arise are as follows:

(1) *What percentage of carbon dioxide is required to extinguish a flame?* Clowes and Feilmann [1] have investigated this problem with various kinds of flame, with the following results:

Percentages of Carbon Dioxide and Nitrogen that Must Be Added to Normal Air to Extinguish Flame.

Burning substance	Carbon dioxide required, per cent.	Nitrogen required, per cent.
Absolute alcohol, ethyl	14	21
Methanol	13	18
Paraffin oil lamp	15	23
Colza and paraffin	16	22
Candle	14	22
Hydrogen	58	70
Carbon monoxide	24	28
Methane	10	17
Coal gas	33	46

It is at once apparent that flame from most burning substances containing carbon is extinguished by adding about 15% of carbon dioxide. Only hydrogen and coal gas fires require more than 25% of carbon dioxide. Acetylene and other "unsaturated" gases also require high percentages. It is beyond the scope of this article to undertake a complete discussion of all the factors entering into the question, and the reader is referred to more detailed discussions in the literature.[2] In the writer's experiments, cover-

[1] Clowes and Feilmann, J. Soc. Chem. Ind., *1894*, 1156.

[2] For a complete experimental study of the behavior of mixtures of methane or natural gas and oxygen, nitrogen, and carbon dioxide, see J. K. Clement, "Influence of Inert Gases on Inflammable Gaseous Mixtures," U. S. Bureau of Mines

ing a variety of combustible substances, the percentage of carbon dioxide required has always been well below 25%, except for flames involving hydrogen or endothermic unsaturated hydrocarbons. Twenty-five per cent has been taken as the basis for the design of commercial fire extinguisher systems, and has been proven to extinguish flame in all types of combustible material commonly encountered.

(2) *What is the effect of temperature?* The percentages of carbon dioxide given above are for air and carbon dioxide at room temperature. When the carbon dioxide is employed at 110° F., carrying in suspension very finely divided carbon dioxide snow, the flame is literally chilled out of existence, even though the actual heat quantities necessary to produce this effect are small on account of the extremely short time required to extinguish flame in this way.

(3) *What is the effect of wind velocity?* If the wind velocity at all points in a burning system exceeds the velocity of propagation of flame, the flame will be extinguished. A striking and extreme illustration of this is the case of an acetylene fire which melted the safety device from an adjacent oxygen cylinder, whereupon the oxygen extinguished the fire by literally "blowing it out." This kind of phenomenon is rarely of importance in practical fire extinction, but it is of real assistance in the application of carbon dioxide, because when carbon dioxide is caused to blow directly at a flame the percentage required to extinguish the flame is lessened by the effect of windage.

(4) *What is the effect of carbon dioxide on fires involving incandescent material, after flame has been extinguished?* The behavior of incandescent material depends upon the following variables, the influence of which is very briefly summarized:

(*a*) The physical condition, or surface exposed, of the incandescent carbon. Thus, wood charcoal is more combustible than foundry coke. Most miscellaneous fires involve wood or cellulose in some form, but no general rule can be given. The less combustible the material, the more readily it will cool, other conditions being the same.

(*b*) The wind velocity or draft is very important. The best illustration of this is a cigar, which will die out if left in still air, but will burn rapidly with high wind velocity. It is possible to keep carbon actively glowing in a gas producer with gas containing less than 5% of oxygen, provided the wind velocity is sufficiently high to overcome the slow rate of oxygen diffusion to the carbon. On the other hand, a single piece of white hot foundry coke will quickly cool without being consumed if taken out into still air containing about 21% oxygen. The conclusion is obviously that there is no definite percentage of carbon dioxide or of oxygen which will insure extinguishing glowing carbon under all conditions.

(*c*) Thermal environment as a factor is best illustrated by exposure fires. Thus glowing carbon which is so distributed as to radiate heat freely[1] will rapidly

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Technical Paper *43*. The present writer has presented other phases of the problem also in Proceedings of the National Safety Council, *12* (1923), 632-42 and 542-8, and in the General Electrical Review, October, 1924. The last named paper also considers the effect of inert gases on incandescent carbon.

[1] For example, on switchboard wiring, glowing spots will usually die out in a few minutes after flame has been extinguished.

cool itself below the ignition point. A glowing match does not again burst into flame. If placed in proximity to a very hot body, however, it will reignite.

(*d*) In the last analysis, the sole object of any fire extinguisher dealing with incandescent material is to reduce the temperature below the ignition point. Once this object is accomplished, the gas composition is a matter of indifference

Limitations of Carbon Dioxide.

It is not the intention of this article to discuss the mass of information and misinformation that may be found in the literature bearing on these relationships. From a practical standpoint, the above statement serves to explain certain limitations of carbon dioxide as a fire extinguishing agent.

I. On fires not involving incandescent carbon.

This class includes all kinds of fire in flammable liquids and gases, oil fires, paint fires, solvent fires, acetylene fires, also fires in which other materials involved act as wicks and thus are protected from charring.[1]

Carbon dioxide is extremely effective on fires of this class, because they can be snuffed out instantaneously, and as a rule will not re-ignite. They can further be protected from reignition until any possibility of such an occurrence can be removed.

The limitation of carbon dioxide systems in this field is a mechanical one, namely, the carbon dioxide can only be used when it is possible to produce an extinctive atmosphere throughout the flame area. To date, this means that such flames can be extinguished on surfaces or in openings not over five feet wide, although further developments may make it possible to treat larger areas in the future.[2]

II. On fires involving little incandescent material.

Most incipient fires fall in this class, and carbon dioxide can be used very effectively on such fires.

Where a closed space that can be flooded with the gas is available, such as the hold of a vessel, a cellar, a mine, or a closed room, such fires can be effectively extinguished with carbon dioxide.

Where no such closed space is available, the only important limitation of carbon dioxide is its short range. Although carbon dioxide snow can be thrown forty feet or more from a special cylinder, good results on extinguishing actual fires in the open air have been obtained only when the fires could be approached within six feet. This includes most incipient fires, but there are many cases where long range is highly desirable.

III. On fires involving large amounts of incandescent carbon or charred material.

Fires belonging to this class must be treated with water unless confined in enclosed spaces where it is possible to retain an extinctive atmosphere until the heat can be dissipated.

Fires in enclosed spaces can be treated with carbon dioxide, but either sufficient time must be allowed to lapse for the dissipation of heat before admitting air, or men provided with oxygen helmets must be sent into the extinctive atmosphere to remove or quench the hot material in order to permit the opening of the space at an earlier time.[3]

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[1] The clothing in a dry-cleaner's washer is a case in point.

[2] It will be apparent that the writer does not anticipate any displacement of foam fire extinguishers in protecting large storage tanks.

[3] In a recent application of this kind of tactics to a mine fire, 10,507 periods of work were performed by men wearing oxygen helmets, who used 210,000 cubic feet of compressed oxygen, and removed 5500 60 cubic-foot cars of caved coal and rock from the mine. See U. S. Bureau of Mines Reports of Investigations, Serial No. 2325, "Fighting a Mine Fire with its Own Gases."

It will be apparent that these limitations delineate a narrow field in which carbon dioxide is useful as a fire extinguishing agent, as compared to water and foam. Within this field, however, the further development of this new fire extinguishing material may be predicted with some degree of certainty.

Mine Fires.

The use of inert gas in fighting mine fires is still a controversial subject among mining men, although practical results obtained by simple sealing, by flue gases, and by carbon dioxide leave no doubt as to their value when employed under the right conditions.

Many unknown variables work against the fireman in applying any kind of fire extinguishing agent, even water, to any mine fire. It is therefore not surprising that all fire extinguishing agents, including water, have a somewhat spotty record in connection with mine fires.

The necessity for using inert gas in fighting mine fires is entirely a question of leakage. When a fire is sealed off, there is always some leakage, and thermal contraction of the atmosphere as the fire cools, together with barometric and thermometric fluctuations, tend to cause more or less air to leak in and feed the fire. When the amount of the leakage is very small, the heat generated by inleaking air will be less than that dissipated by radiation, conduction, and convection, and the fire will smother itself. When the leakage is more considerable, it can be offset most economically by introducing liquefied carbon dioxide at a controlled rate into the fire zone. When the leakage becomes so great as to warrant the expense of installing a special furnace and cooling means for making flue gases on the ground, flue gas can be used more economically. The writer has discussed the application of carbon dioxide to mine fires at length elsewhere in the literature.[1]

During the last two years, carbon dioxide has been applied to three coal mine fires. In one case, the management reports complete success. In the second case, the management reports that the expense was not justified. In the third case, a very great improvement in condition of the mine was effected, fully justifying the expense, but the fire was not entirely extinguished in one end of the mine where leakage made the gas ineffective.

As experience in applying the method is accumulated, it may be confidently predicted that it will continue to be successfully applied where it is technically controlled.

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[1] Coal Age, *24* (1923), 3-10; Coal Industry, June, 1923; Quarterly N. F. P. A. *17* (1923), 42; Coal Mine Management, March, *1924*, 34; Proc. Nat. Safety Council, *1923*, 632-42.

Fig. 2. Cylinder room on M. S. Challenger. This small room carries about 5000 lbs. of liquefied carbon dioxide, which protects the entire ship.

Marine Fires in Closed Holds.

The carbon dioxide method of fighting fires has had its greatest development in the marine field, on account of the favorable conditions for smothering which surround fires in the holds of vessels. Even in this field, however, the method is in its infancy.

The writer has discussed the use of carbon dioxide in marine fires elsewhere in the literature, and will hence allude to it here only briefly.[1] The development which has made the use of liquefied carbon dioxide a practical possibility in extinguishing marine fires is the Lux system, originated in Sweden, whereby it is possible to procure rapid discharge of carbon dioxide without freezing or stoppage. The carbon dioxide storage in the M. S. Challenger is illustrated in Fig. 2.

Some of the advantages of carbon dioxide are given below:

1. It is non-injurious to all types of cargo and to the ship's structure.
2. It leaves no residue.
3. It is effective at all temperatures, and will not freeze in the coldest climate.
4. It does not deteriorate, being good until used.

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[1] Proc. National Safety Council, *12* (1923), 632-42.

5. It requires no maintenance other than the weighing of the cylinders once or twice a year.

6. The system is lighter in weight for the results produced than any other fire extinguisher, generating an average of 9 cubic feet of smothering gas per pound of liquid, and exerting under average conditions over 100 B.t.u. per pound cooling effect. In comparing this with water, allowance must be made for the very small percentage of water thrown that is actually vaporized on the fire. Thus, while water striking a fire is theoretically capable of absorbing nearly 1000 B.t.u. per pound when it is vaporized, it is conservative to estimate that less than five per cent. of the water thrown on the average fire is fully effective in cooling, and is converted to steam. The physical condition of the carbon dioxide snow, which is projected to the fire suspended in finely divided form, makes its cooling effect largely available in cooling whatever it strikes. It is on this account that carbon dioxide often shows an effect on fire beyond what would be predicted from a consideration of the weight and heat capacity of the carbon dioxide used.

7. One volume of liquid in the cylinder produces from 400 to 500 volumes of smothering gas. On account of this large volume ratio, small piping is used, which keeps down the installation cost.

8. Replacement of the carbon dioxide is not expensive.

9. Perhaps the greatest advantage of carbon dioxide is its faculty of penetrating to inaccessible places. Fires at all levels, bilges, floor plates or shelves, or in the trunk, are extinguished even though they would not be accessible to streams of water or foam.

10. The system has been developed so that any fire not involving a great deal of incandescent carbon, such as an oil fire in the engine room, can be extinguished without closing ventilators. Even fires involving moderate amounts of waste, wood, paper, etc., can be extinguished in carbon dioxide equipped motor rooms.

At the present time the tendency of many ship owners is to regard the installation of safety devices entirely from the standpoint of insurance cost. The result of this policy in the marine field is not as salutary as on land, since marine insurance is written without the scientific attention to safety devices characteristic of land fire underwriting, and no specific rate reductions can be obtained by the ship-owner as a result of installing protective devices. This condition is rather obviously the out-growth of European tradition, and is not due to backwardness on the part of American marine underwriters. However, it has resulted in confining the use of carbon dioxide largely to motorships, which do not possess adequate supplies of steam.[1]

In the past, many well-informed persons have objected to the use of carbon dioxide in places accessible to the crew, although recognizing the non-poisonous nature of the gas, and the possibility of leaving a room after carbon dioxide has been admitted without being suffocated.

On the other hand, engine room fires have been extinguished after other means had been abandoned, by the crew retiring from the engine

[1] For a comparison of steam with carbon dioxide as a smothering agent, see Proc. National Safety Council, *12* (1923), 632.

Fig. 3. Test fire in full size model of motor room of 75 ft. coast guard cruiser. 178 of these boats are being equipped with carbon dioxide extinguisher systems.

room, closing the doors, and introducing carbon dioxide from the ship refrigerating machine supply through the ventilating hatches.

Some tests on a full size reproduction of the motor room on a coast guard cutter are shown in the photographs, Figs. 3 and 4. These tests were entirely successful in extinguishing fires of oil, wood, waste, and other combustibles, even with the ports and ventilators open. It seems clear that if proper safeguards are thrown around the operation of such a system, it may afford valuable protection without hazard to life and limb. Especially is this true in the marine field because of the desperate nature of many fires of this character.

Fires in Cellars, Warehouses, Dust Collectors, and the Like.

This apparatus, which has reached its highest state of development in the marine field, is directly applicable to many special problems on land, in fact, such apparatus can be used wherever it is possible to keep a fire fairly well enclosed. Practically nothing has been done as yet to bring such a development to pass, but one or two cases will show the possibilities of the scheme.

Fig. 4. The test fire (see Fig. 3) extinguished one minute after releasing carbon dioxide. The white cloud is not smoke or steam but is carbon dioxide snow.

A fire in the interior of a coal pile behaves somewhat as though enclosed in a leaky room, since the surrounding coal limits the access of air. In November, 1914, a coal pile containing between two and three thousand tons of coal caught fire in Stockholm, Sweden. After an unsuccessful attempt to extinguish it with water, it was extinguished by means of a hastily commandeered marine fire extinguishing apparatus, with a consumption of about 1000 pounds of carbon dioxide. The Fire Department of the City of Stockholm has since been equipped with a motorized adaptation of the marine fire extinguishing system, comprising 40 cylinders of liquefied carbon dioxide.

A recent fire in an aluminum bronze powder plant in the middle west was extinguished by closing all doors and windows of the room, and injecting the contents of all the carbon dioxide cylinders that could be collected from adjacent laboratories and soda fountains.

Tests on spray-dried lime sulphur solution have proved that fires in this material can be easily extinguished with carbon dioxide, with no damage to the material other than that done by the fire. The results of these recent tests have not been commercialized.

Considering the comparatively tight construction employed in building the modern storage warehouse, it would be comparatively easy to adapt marine carbon dioxide apparatus to warehouse fires. It is not to be supposed that such an adaptation would take the place of automatic sprinklers in general use. However, the following logical method of extinguishing fires in storage of valuable merchandise, which would have been highly impracticable a decade ago, seems likely to be fulfilled within the next decade.

When fire is discovered, for example, in some silk or fur storage, all doors and windows will be closed. Having made sure that no one is in the space thus enclosed, carbon dioxide will be introduced under the supervision of a properly qualified expert until the concentration reaches about 25%. All flame will then be extinguished, so that any combustion in smoldering charcoal or fiber cannot spread rapidly from its source.

Men equipped with oxygen breathing apparatus will then enter the space and investigate. It may be necessary for apparatus men to move other merchandise to get to the seat of the fire. It may be necessary to maintain the gas atmosphere for several hours until the smoke present has cleared away sufficiently to enable men to investigate intelligently. The fire may not be entirely extinguished meanwhile, but it cannot spread. When the seat of the fire is found, if it is not already extinguished, the burning material may be removed from the storage space, or quenched with a comparatively small amount of water, with no interference from flame or smoke. The apparatus men may then be withdrawn and the space ventilated.

Is this suggestion visionary? Perhaps it is, if judged in relation to present conditions. When the progress made by the United States Bureau of Mines along similar lines in mine rescue work is considered, however, the possibility of reducing our tremendous fire damage by such means should not be discarded without very thorough consideration.

All that has been said with regard to warehouses will apply to cellars, but the necessity for dealing with cellar fires under varying conditions, with whatever fire department personnel happens to be available, makes the cellar fire a less promising avenue for further progress in applying inert gases than the warehouse.

Fires in Electric Generators.

The more modern types of electric generators are equipped with closed-circuit ventilating systems which render them ideal for the application of inert gases.

Systems using carbon dioxide for extinguishing generator fires have recently been installed in the South Meadow station of the Hartford Electric Light Co., and in the Cahokia and Ashley St. Stations of the

Union Electric Light and Power Co. of St. Louis. Systems now under contract or projected will considerably increase this number within the next year, and it is believed that the record of progress which might now be written on this subject will become a record of achievement within a comparatively short time.[1]

First Aid Extinguishers for Electrical Fires.

No first-aid carbon dioxide extinguisher for electrical fires is as yet actively on the market in the United States. Pending the consideration of such an extinguisher of this type by Underwriters' Laboratories, the writer prefers to make no broad claim of superiority for extinguishers of this type. It is believed, however, that the photograph, Fig. 5, will be of interest. It shows a hand extinguisher[2] recently developed through co-operative effort of the Bell Telephone Co. of Pennsylvania and the Mellon Institute of Industrial Research. It will be evident from the photograph that the carbon dioxide snow discharged is tangible. The extinguisher is so designed that it will discharge carbon dioxide gas and snow at —110° F. at a uniform rate for about 45 seconds. The liquid is then exhausted, and the extinguisher discharges gas without any snow for an additional two minutes.

Fig. 5. Dry Carbon Dioxide Extinguisher discharging CO_2 Snow—Telephone Co. type.

This extinguisher was submitted to a practical test on fires in various types of telephone switchboards, with entire success in extinguishing any fire that could be built in full size switchboard panels.

From an electrical and chemical standpoint, extinguishers of this type stand alone. The carbon dioxide is not poisonous, and it is not possible to build up a dangerous concentration throughout even a small room with the contents of a hand extinguisher. The gas has absolutely no effect on insulating materials, nor upon the metal of the electrical apparatus. It is a non-conductor and is used in a dry state, causing no trouble from moisture. No other fire-extinguishing material possesses all these characteristics.

[1] Electrical World, *80* (1922), 165-7; *idem*. 1089-91; General Electric Review, October, *1924*.

[2] This extinguisher is described in Electrical World, *83* (1924), 1133.

Fig. 6. Fire in laboratory extinguished with German dry carbon dioxide extinguisher. No damage to open file drawer below the fire.

The principal limitation of this extinguisher lies in its comparatively short range.

First-Aid Extinguishers for General Purposes.

No hand extinguisher of the dry carbon dioxide type yet developed can compare in range with the approved types of soda-and-acid or carbon tetrachloride extinguishers. However, most incipient fires can be closely approached, and the extinguisher developed for the Bell Telephone Co. could be successfully used on many small fires, with an entire saving of extinguisher damage.

The greatest advantage of the carbon dioxide extinguisher is this freedom from any damage done by the extinguisher. This point is nicely illustrated by a fire at Mellon Institute August 15, 1924, which was extinguished with a German "Total" fire extinguisher of the dry carbon dioxide type,[1] illustrated in Fig. 6. The "Total" extinguisher comprises a small cylinder of liquefied carbon dioxide and a larger cylinder of sodium bicarbonate powder. It is so designed as to discharge a cloud of powder uniformly suspended in inert gas, and is not to be confused with dry powder extinguishers sold in the United States.

In this case the photograph tells most of the story. A small but nasty oil fire followed an explosion on the shelf, just above an open cabinet containing papers. The fire was extinguished as easily as could have been accomplished with any hand extinguisher, but without any damage whatever to papers six inches below the flames. It is believed that this freedom from water and chemical damage is peculiar to the carbon dioxide extinguisher.

The future alone can define the field for hand extinguishers of the dry carbon dioxide type. In any event it will be some time before any extinguisher embodying recent developments in carbon dioxide discharge can be gotten before the public.

Extinguishing Oil Tank Fires.

Gasoline burning in a narrow-mouthed bottle represents a type of fire to which carbon dioxide has been applied successfully. Obviously, in such a case, the oxygen is soon consumed in the receptacle, and the vapor then burns at the opening. If the flame can be cut off even for an instant the fire will be extinguished. Only where a source of ignition is present is it necessary to maintain the protection for any length of time.

The case of the narrow-necked bottle is a simple one, because a stream of compressed air or steam directed across the mouth would probably extinguish the fire as well as carbon dioxide, except for the cooling and smothering effect of the last named gas. However, as the size of the opening increases, the problem rapidly becomes complicated, and the larger openings require properly shaped and properly spaced orifices for discharging the carbon dioxide across the mouth of the opening. Further, these orifices must discharge in more than one plane, with the proper angle between the planes of discharge. These details are critical, and an improperly proportioned apparatus simply will not extinguish fire. W. H. Freygang[2] has studied the problem empirically,

[1] This extinguisher is not now on the market in the United States, but is meeting with favor in Europe. It is a familiar sight to travelers on the newer boats of the Hamburg-American line.

[2] Oil and Gas Journal, August, *1924*.

Fig. 7. Test of carbon dioxide system on oil fire; conditions simulating tank ship, opening five feet square. The gasoline fire shown had been burning eight minutes when the picture was taken. Wind velocity 40 M.P.H.

and has succeeded in developing a simple apparatus capable of extinguishing any flame issuing from an opening not over five feet wide. The apparatus required is quite simple, and consists of pipes on each side of the opening, bearing orifices of the proper shape, and placed in the right planes and at the right spacing.

A test of this apparatus on an opening five feet square is shown in Figs. 7 and 8.

It will be apparent to the reader that this system does not compete with foam systems in protecting tanks or openings more than five feet across. For the special case of oil tank ships, however, the carbon dioxide system has the advantage of having a fraction of the weight of a foam system for the same purpose, and it can be installed at a fraction of the cost. It requires very little gas to snuff out a flame with this equipment, less than ten pounds sufficing in the test fire illustrated. In the practical installation, a sufficient reserve is provided to maintain the protection for some time in case there should be a source of ignition above the opening, such as very hot steel work.

This equipment should be applicable to special problems in fire protection on land, but the development is as yet too new to state with certainty just what may be done with it.

Fig. 8. The fire blown out (see Fig. 7). The white cloud is carbon dioxide snow.

General Use of Carbon Dioxide in Fires in Buildings.

Over ten years ago a fire in a storage room containing wooden patterns was extinguished with carbon dioxide. The patterns were burning fiercely, and the result obtained shows at least that carbon dioxide will extinguish fire.

This fire occurred in the plant of the Carbon Dioxide and Magnesia Company in Philadelphia, where carbon dioxide could be manufactured and pumped direct to the fire. It is therefore a special case, and probably does not indicate any general use of carbon dioxide by fire departments on ordinary fires.

Conclusion.

This article has attempted to outline the present extent of the use of carbon dioxide in fire protection and to point out some possible avenues of future development. The embryonic status of many of the developments renders this article distinctly a progress report, and does not discuss all the possible applications of this interesting material.

Pumpers and Mill Yard Hydrants.

By Charles E. Worthington.

(Member N. F. P. A.)

Insufficient water pressure, hampering the work of fire departments, figures prominently in the newspaper reports of the majority of conflagrations and of fires destroying extensive manufacturing properties. Why is it that insufficient water supply and conflagrations go hand in hand?

As a rule if the water supply is by gravity from a reservoir it will be found that the gates were wide open during the fire and all the water that the system was capable of supplying was supplied and at the normal pressure. Or if the water system depends upon pumps, it will be found that the pumps were promptly started and operated to their full capacity. Clearly the fault is not usually at the source of water supply.

Generally speaking the demand in event of a serious fire is for water and more water, whereas at best the volume that can be drawn through ordinary mains is of necessity limited, not only by the size of the mains but by the rapid increase of friction when it is sought to increase the velocity of the water by enlarged withdrawal.

We should bear in mind that by no means, by application of vacuum at outlets or by any other device, can the inflow of water to a main be increased beyond the amount normally supplied at the existing head or pressure. Attaching the suction of a pumping engine does not produce a larger output at the outlet than would be realized by opening the outlet fully without any suction.* Water cannot be pulled through a pipe faster or in larger volume than that produced by the normal head or pressure; but on the contrary, if that initial pressure be increased you can push through a much larger volume, a volume limited only by friction.

It is probably impracticable to provide mains large enough to deliver water in sufficient volume to maintain pressures at the point of withdrawal in all emergencies. Domestic service requirements can be met with the use of quite small mains. To meet all possible emergencies would require the laying of mains so large as to be of prohibitive expense; for a fire main to be *completely* serviceable in event of a large and severe fire it would need to be many times as large as simple service mains. A com-

*Note: This statement is literally true if a flexible suction hose is used, which will collapse if the pressure is reduced below zero, gauge. If the suction hose is rigid, permitting the maintenance of a vacuum, the actual quantity of water withdrawn from the hydrant can be somewhat increased. This increase, however, is not sufficient to affect the conclusions drawn in this article.—Ed.

promise is necessary, and a supply for ordinary emergencies provided.

In the case of large aggregations of combustible material and big values at stake, as in manufacturing plants with many extensive buildings, the construction usually predates the installation of water mains for public use and the expense of replacing the mains is too great to be considered. The inadequacy of the public supply to afford the volume of water and the pressures required in the emergency of a considerable fire in such properties is generally recognized and a remedy sought by means of a private fire system, a series of mains with hydrants and supplying automatic sprinkler systems, connected at one point with the public mains and at another with one or more high pressure fire pumps; and not infrequently supplemented by a tank or elevated reservoir of considerable size. The pumps, supplied from some considerable natural or artificial body of water, are relied upon where high pressures are required, and the public supply comes into action automatically as pressures fall from increasing withdrawal.

The theoretical operation is this: water is taken at the pressures afforded by way of the intake from the public service and the pump or pumps started as promptly as possible. These usually operate at a considerably higher pressure than the public service affords and upon coming into action the check valves shutting out public service are thereby closed, the higher or pump pressure continuing until withdrawal by fire streams or sprinklers or both *exceeds* the delivery of the pumps. Then the check opens and the pressure falls to that of the public service.

More Pumps, But No More Fire Streams.

It is obvious that the number of fire streams at a higher pressure than the public pressure is strictly limited to the number of such streams the pump service can supply, and the full value in high pressure streams can be had only by limiting their number. This is a somewhat difficult thing to do since as a rule the number of available hydrants is such as to permit of a greater number of hose streams, the usual disposition being to call into action everything in sight so insistent seems the demand for water and so obvious is the fact to each hose crew that their need is pre-eminent. This may be lack of discipline and competent oversight to a large extent but all too often discipline breaks in the face of threatened calamity.

The theory upon which our customary scheme of private fire protection is based is not open to criticism as far as it goes and in fact it works well. However, we may lay down as a primary principle that it is not possible to have too much water and too much pressure available; if more than a certain amount is not needed the fact of its availability does no harm, whereas a deficiency is apt to have unpleasant results.

It is quite reasonable therefore to inquire as to whether in some cases we are availing ourselves of all the means practicable of developing a large number of high pressure streams without materially increasing the expense of installation.

In completely isolated properties depending solely upon the private apparatus it is evident that we have gone as far as we can in the way of providing several water supplies, but in general where a public supply is available there is usually a public fire department of some sort which is expected to be promptly summoned and whose chief is expected to take charge upon arrival at the fire.

Now let us see what happens, using as an illustration a private installation of the usual type with a public primary supply and a four stream fire pump kept under steam pressure.

Fire breaks out and the yard hose is brought at once into use and as many streams as there are men to handle are attached to the nearest hydrants. Suppose that static pressure is 70 pounds and four streams are put into use. At once the pressure falls from 70 pounds according to conditions to perhaps 40 pounds or less, which is insufficient. Then the pump, operated say at 125 pounds, comes in to restore the pressure or even raise it above normal; at the same time the fire department is notified.

Fire Department Pumpers Should Not Use Yard Hydrants.

The department arrives with, say, two pumping engines; the firemen know their apparatus and trust to it, and they are further so accustomed to coupling to hydrants for suction that it is second nature, practically instinctive. At once the pumpers are run into the yard, coupled to the private hydrants, and begin work delivering four streams.

Where do they get the water? The water pressure in the mains at the time of their advent is solely derived from the fire pump and consequently the water for the four streams is taken from that supply. And, what is of greater importance, the pump supply, intended to maintain four high pressure streams, is wholly consumed, so we have a four stream stationary fire pump and two fire department pumpers, capable in all of delivering eight high pressure streams, and we are developing but four. We have merely substituted the portable pumps for the stationary without increasing our delivery. We ought to get the eight streams but we do not. And, what is more, this is not a theoretical condition but one that has occurred with serious results; private pumps capable of excellent service have been eliminated in this manner; elevated tanks designed as a final resource have been emptied merely to supply the pumpers. It has not so happened many times, but it is always likely to happen.

Evidently the first step in a reform which will tend to discourage this misuse of yard hydrants is to cease installing private hydrants with special

3½ in. or 4 in. outlets for pumping engine suction connections. This of course is nothing absolute, since the pumpers can use two 2½ in. suction lines siamesed; but since this involves some trouble and delay in getting into action, something distasteful to ordinary firemen, it makes it a trifle easier to educate them in this matter.

The second step is to arrange to have the pumping engines take suction from the mains or other sources of supply entirely outside of the yard and discharge the water into the private mains inside of the check valve, thus raising the pressure at the hydrants and securing for use the entire volume of discharge.

When we have done this and educated the fire department to the proceeding, we will be able to get eight streams at full pressure with two pumping engines and the stationary fire pump operating. In other words, we have doubled the number of our high pressure streams without increasing pumping machinery. There is probably no case where this cannot be easily brought about so far as installation is concerned, and the possible ultimate efficiency of the private installation largely increased.

The advantage of some such method can be summarized thus: The entire discharge of any number of public pumpers can be conducted into the private mains and utilized without robbing the stationary fire pump discharge. This entire discharge and increased pressure will be available at all of the private hydrants and on all sprinkler supplies with a minimum loss by friction. The number of pumping engines that can be utilized will be limited only by the extent of the provision for discharging into the private mains and the ultimate conducting capacity of the mains.

The pumping engines (which are pumps on wheels merely) will be able to take suction from mains of larger diameter than the intake of the private system and not infrequently from other permanent sources wholly independent of the water system; consequently many more pumpers can be employed (if they exist) and a great deal more water can be had at higher pressures.

The safety of the pumping engines will be assured. We are as a rule particular about locating the stationary fire pump in the safest possible situation, as little exposed to destruction by a fire in any part of the plant as conditions will permit, and in housing such pumps in highly fire-resistive structures easy of access despite any fire. It is hardly logical to encourage locating the movable pumpers at points where they are exposed to fire or falling walls since their value is at least the equivalent of stationary pumps of like capacity. We can prevent the loss of apparatus by the simple process of locating the pumpers where they are absolutely secure. Losses of pumping engines trapped by fire or by falling walls are by no means infrequent and result not only in financial loss but cripple the fire fighting operations. Streets and passages in mill yards are

necessarily narrow as compared with public streets and in exactly that degree congestion of apparatus and obstruction of full movement of men handling hose becomes important. No one attending a serious fire in the business district of a city can fail to realize the difficulties of movement attendant upon the congestion of apparatus in the streets, even the broadest of streets. Anything tending to lessen or remove this congestion without diminishing water supply and pressure is a distinct aid to efficiency.

Attaching a pumping engine to a hydrant where sufficient pressure can be produced in the hydrant gives no advantage; the pumping process is a needless one; the amount of hose to be laid is not diminished, as the pumper ordinarily must stand very close, only a few feet of large suction hose being carried, and the hose connections in each case are identical.

The author has here endeavored to bring out as clearly as possible the apparent fact that we do not always get as much protection as we should and could get with practically no increase in cost of installation, and to point out wherein the defect lies and the possible remedy. Certainly the ever present possibility that severe loss otherwise avoidable will result in more than one instance in the future from the completely avoidable drawing down of general pressures by pumping engines is enough to at least justify careful consideration of the problem. We can never have too much effective fire protection.

The rearranging of present systems by bushing down the pumper suction connections to form 2½ in. connections, and the comparatively inexpensive process of arranging to have the public pumping engines take suction from public mains outside the check valve and deliver into the private mains inside of the check, will at least secure the maximum of water and of pressure under all conditions. It will avoid as a rule drawing down pressures for sprinklers and emptying tanks connected to yard mains.

The chief drawback in this plan lies in educating fire departments in the necessary departure from established routine. This would have been a real obstacle a few years ago, but in this day it should not be a difficult matter. Probably not a few can remember when a proposal on the part of a fire captain to connect his engine to an automatic sprinkler supply would have been met by a threat of instant discharge from the department if he carried the proposal into effect. Yet such connection is the standing rule in all departments today.

The general efficiency of present fire fighting methods is not in question. But do we get all we can or should get by them; and is it possible, without undue expense, to get more, and thus be at least better prepared for possible emergency? Within the last two or three decades we have reformed a great many practices in the interest of greater security

and efficiency, so that of present methods this is nearly the only one calling for consideration. It really seems worthy of such consideration, the more so because no appreciable increase of cost is involved, and no inconvenience or added difficulty of maintenance is involved.

Handling Celluloid Safely.

Celluloid can be handled safely in manufacturing rooms. This was demonstrated by a series of practical tests recently made at the Factory Mutual Testing Station. The word "celluloid" is used here in its popular sense to include pyroxylin plastics in general, such as combs, spectacle rims, handles for table cutlery, toothbrush backs, and numerous toilet articles. Legally, it is the name of the product of a single manufacturer.

Not only the fire hazard is involved when celluloid is handled in large quantities, but the safety of employees as well, for the material ignites easily, burns rapidly, and what is more dangerous, decomposes and gives off great clouds of poisonous and explosive gases,—two hundred times the volume of the original material,—if it is heated sufficiently, whether it burns or not.

The violence of the decomposition can be seen from Fig. 1. This shows the gases from five pounds of scrap celluloid blowing out of a three-inch hole in the top of a wooden box. The decomposition was started by the heat of an electric resistance unit at a temperature of about 350° F.

The enormous volume of the gases given off can be judged from Fig. 2. This was taken while a wastebasket-full of celluloid scrap was decomposing. The action was started with an electric resistance unit, as before. In one of the tests the gases caught fire before decomposition was completed. This was due to the spontaneous ignition of the charcoal residue which was left. If the gases had been confined, as in a room, the result would have been a violent and destructive explosion.

Tote-Box Fires.

The tests were continued by setting fire to piles of factory tote-boxes or wooden trays, 18 in. x 13 in. x 4 in., each about half full of broken and rejected toothbrush backs. The first pile was arranged in four layers of six boxes each, with strips of wood between the layers, as is sometimes done in practice to afford ventilation. The celluloid was ignited in the bottom corner box. The flames of burning gas jumped from this box to the others and quickly consumed all of the celluloid, although nine sprinklers operated. The boxes continued to burn for nine minutes, as the water could not play freely upon any but the top layer.

This article is reprinted from the Factory Mutual Record, published by the Inspection Department of the Associated Factory Mutual Fire Insurance Companies (Member N. F. P. A.).

Fig. 1. Violent decomposition of celluloid without fire. Five pounds of scrap celluloid in wooden box with three-inch hole in top.

In the next test half of the boxes were piled openly, as before. The remaining boxes were stacked with the wooden strips running along the tops of their long sides so that only the ends of the boxes had open joints. By this method of piling, the celluloid in each row of boxes was separated from that in the next row by double-thick partitions, consisting of the sides of the boxes and the strips along the tops of the sides. This closely piled half was covered with a layer of boards.

The fire was again lighted in a lower corner box of the openly piled section. As in the previous case, the flames almost immediately communicated to all of the boxes piled with open joints, but the fire did not extend to the remainder of the pile. The close piling, combined with the board covering and assisted by the water from three sprinklers, fully protected the celluloid. It was not even decomposed.

These tests showed that if celluloid is stored and handled in loosely piled trays and should become ignited, fire would flash throughout a workroom even under sprinkler protection as ordinarily installed. But if the boxes were piled with the sides together and the tops covered, the progress of the fire would be retarded and probably checked by the sprinklers. This, and an even better method of storage, was demonstrated in the next test.

Wooden Storage Cabinet.

A wooden storage cabinet was constructed, containing twelve drawers of convenient size to handle, having sides and bottoms of ¼-in. lumber and the ends of ½-in. stock. The front end of each drawer had overlapping and tightly fitting edges. The rear end was notched so that

Fig. 2. Decomposition of scrap celluloid in wire waste basket. Showing enormous volume of gas given off. The hot carbon residue sometimes ignites spontaneously, setting fire to these gases. If confined, a violent explosion would occur.

the gases given off by the decomposing celluloid would exert pressure against the back of the cabinet and force the drawer open. The horizontal and vertical partitions between the drawers were of 7/8-in. matched boards. Five to eight pounds of scrap celluloid was placed in each drawer and a fire was started in one of them near the center of the cabinet. The fire went out due to lack of oxygen, but all of the celluloid in the drawer was decomposed, the gases escaping at the front end.

The same drawer was then refilled with scrap and left partly open. A match was thrown into the drawer, producing the result shown in the photograph at the bottom of page two. The gaseous fire in this compart-

Fig. 3. Celluloid burning in open drawer of storage cabinet. The flare of burning gas did not last long enough to open sprinklers. Wooden cabinet retarded spread of fire so that eight minutes elapsed between the burning of successive drawers.

ment consumed the celluloid so quickly that no sprinklers opened in the test house. The wooden drawer, however, had caught fire and continued to burn lazily. But it was nine minutes before the partition had burned through and set fire to the celluloid in the closed drawer above. As before, the flare of this second fire was insufficient to open sprinklers. After eight more minutes had elapsed, another drawer, this time to the right of the second one that burned, was heated enough to catch fire. The celluloid in it was consumed with a sudden flame.

At any time during the intermittent burning of the contents of the individual compartments the fire could have been extinguished with water

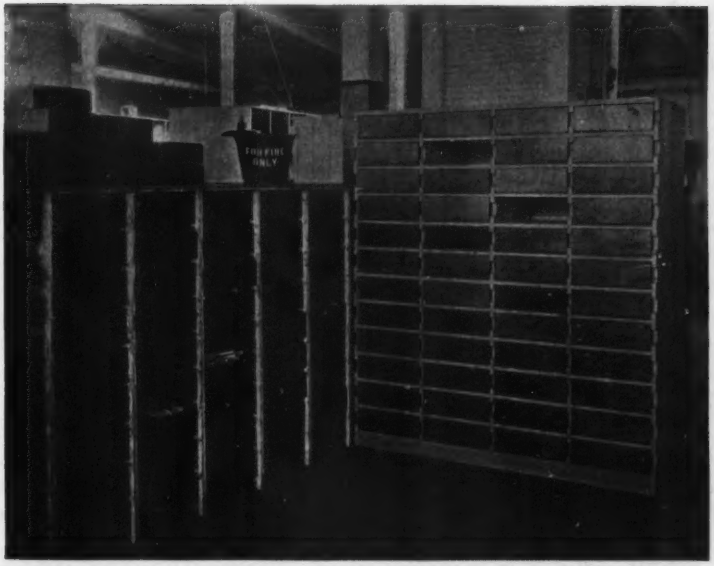


Fig. 4. Wooden cabinets for storing celluloid in manufacturing rooms, Florence Manufacturing Company. At left of picture note old cabinet with open joints between the tote-boxes. At right, note new cabinet with tight joints, thus subdividing the material into small lots, preventing spread of fire.

from a fire pail or chemical extinguisher. After the fourth drawer had ignited, eighteen minutes from the start, a small hose stream was used to extinguish the fire. Upon opening the remaining eight drawers of the cabinet, it was found that the celluloid had started to decompose in one, but was intact in seven.

Conclusions.

The way to handle celluloid safely in manufacturing rooms is obvious from these tests. Ordinary prudence would suggest bringing only one day's supply into the building at a time. The material in process can be handled in wooden tote-boxes of convenient size but uniform in dimensions. Between one operation and the next, and also at night, or whenever the plant is not in operation, they can be kept in a suitable cabinet with compartments into which the tote-boxes fit tightly. This will afford excellent protection by retarding the spread of decomposition or fire.

The celluloid scrap which accumulates from manufacturing operations should be constantly cared for. For this purpose a liberal number of waste cans should be provided, and frequently emptied. Finally, and of course most important of all, there should be ready means of exit for employees.

An Interesting Record Loss Fire.

By E. C. Roddy.

(Member N. F. P. A.)

Newspapers in all parts of the country carried the story of a Perth Amboy, N. J., fire that destroyed the Dana Building in that city on last Washington's Birthday. The news value of this fire was enhanced by the fire destroying the premises of Judge Harold E. Pickersgill, the noted collector of Colonial books and manuscripts. Most of the newspapers stated that these historical records were completely destroyed and they cited manuscripts of Washington, Lincoln, etc., as falling a prey to the flames.

Although 4000 volumes of English, French and American books were on open shelves and, of course, destroyed, together with a number of Colonial maps and charts which were displayed in frames, the bulk of Judge Pickersgill's collection was absolutely protected in two modern fire-resistive safes.

The writer has on several occasions opened safes after a fire and has seen business records restored intact and unharmed to the firm or corporation, but never before has had an intimate contact with the actual

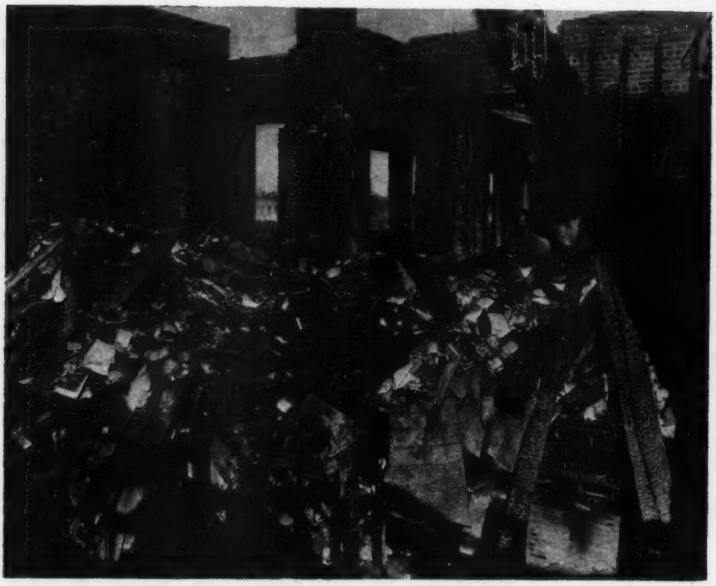
Total loss of iron safe of an obsolete type, containing Masonic Records of Colonial days.

One of the safes that preserved irreplaceable historic documents. Note melted door handles and burned steel.

Historic records saved in modern fire-resistive safe. Contents valued at $22,000.

reclamation of things far more valuable than business papers of mere monetary worth. That this interest was not merely a personal one was most evident from the fact that thirty-six hours after the fire had been extinguished, hundreds of people stood in the snow and slush awaiting for the verdict on the safes. The newspapers had played up the historical value of the Judge's collection and it seemed that all of Perth Amboy and the surrounding area were personally interested in the recovery of the manuscripts and records that had played such a tremendous part in United States history. This was even more dramatic when it is considered that the fire burned all day on Washington's Birthday and in those smoking ruins were the original records that made history in Washington's own trying time. Hundreds of school children had a most direct interest as all of them had heard Judge Pickersgill lecture on Colonial History in the schools. Officials of various historical societies and of the Sons and Daughters of the American Revolution were anxiously awaiting a definite disclosure of whether these archives of history were saved or irretrievably lost.

For a day and a half, or since the fire started, Judge Pickersgill had been almost frantic in his anxiety as to whether his labors of forty years were forever wiped out. Had there been a loss it would not have been



Remains of Early Colonial and Old English Law Library.

Judge Pickersgill's loss alone. The saving of these historical records, likewise, was not merely Judge Pickersgill's gain.

With the open doors of the two large safes facing the crowds, Judge Pickersgill brought out record after record and book after book that told anew the country's history. No Washington's Birthday celebration in 1924 had a more dramatic setting, or a more attentive audience than did this episode in the fire ruins at Perth Amboy.

We saw again Washington and his compatriots—the letters of Henry Clay, manuscript speeches of John C. Calhoun, the military reports of General Greene and other Revolutionary officers. Preserved intact was the only known copy of the first book printed in the Colony of New Jersey. Colonial manuscripts far antedating the Declaration of Independence had been brought back. The early Colonial history of East Jersey and West Jersey and the original poems in manuscript of the Revolutionary poet Freneau would live again.

This Perth Amboy fire, along with all the other fires that have resulted in either complete or partial destruction of the country's irreplaceable archives, teaches that all historical records, whether in official or private hands, should be given the utmost degree of protection obtainable. Every year records that tell, first handed, the country's history and development from its very inception are the prey to flames in various parts

of the country. One of the historical collections owned by Judge Pickersgill was the residue of a large collection owned by a Paterson, N. J., collector. This collection was almost totally destroyed in the Paterson conflagration of a generation ago and the Perth Amboy fire was the means of wiping out some of the remaining documents.

Tanneries—Fire Record.

By W. D. Milne.

(Member N. F. P. A.)

In a critical examination of the fire record of any particular industry it is important to develop the degree of hazard which attaches to the principal conditions, processes, or materials which are characteristic of that industry and serve to distinguish it from others. The immediate causes of fires are perhaps less important than are the surroundings of the fires in their incipient stages. A match is harmless in its proper place, but dangerous in such a place as a picker room, so that it is the picker room rather than the match that constitutes the hazard. In the present study of the fire record of tanneries an attempt has been made to emphasize the hazard which attaches to such operations as bark grinding, buffing, drying, hair drying, japanning, and others which are more or less commonly found as distinct operations in tannery plants, making the immediate cause of the fire a secondary consideration.

In the records of the Association the reports on tannery fires are divided into four groups according to their occurrence in (1) Tanneries, (2) Morocco Leather Factories, (3) Skin Mills (glove leather works), and (4) Patent Leather Works. The classification is not sharply defined, but serves to distinguish certain rather broad classes of tanneries.

1. Tanneries.

In the first classification of tanneries are included sole leather, belt leather, calfskin and other tanneries on the heavier or rougher grades of work, including curry shops, etc.

Of 245 fires noted in works of this class, 122, or practically 50%, were more or less definitely connected with special hazards characteristic of the class, though the immediate cause attributed in several of these may have been a common hazard or was not definitely stated.

Thirty-six of these fires arose in dry rooms or lofts used for drying the leather and emphasize the importance of such areas as affecting the total fire risk. The peculiar construction and condition of such dry lofts contributed materially to the spread of fires originating elsewhere in a

considerable number of cases, but this effect can not well be shown here. In the 36 fire reports selected in this group, the immediate causes of fire were listed as follows:—

Ventilating fans and their power	12
Spontaneous heating of skins or rubbish	5
Motors and switches	4
Heating pipes against woodwork	2
Sparks from external sources	2
Incendiary	1
Shafting	1
Unknown	9

Eighteen fires occurred in connection with the operation of drying hair. The immediate causes attributed in these appeared as follows:—

"Dryer fires," no definite cause assigned	8
Stock or droppings in contact with steam pipes	7
Spark from fan	1
Smoking	1
Candle light	1

Twenty-two fires were connected with the operation of grinding bark, with assigned causes as follows:—

In bark grinding room, cause unknown	8
Sparks from grinder	4
Sparks from yard locomotives	4
Hot bearings on grinder	3
Jam in conveyor	1
Bark against boiler setting	1
Thawing pipes	1

NOTE: One of the fires from spark from grinder caused a dust explosion and the resulting loss was $800,000.

Thirteen fires occurred in buffing machines or in the dust flues or dust bins connected therewith, the causes being stated as follows:—

Sparks from the machine	7
Spontaneous heating of buffings	6

Fourteen fires were attributed to the spontaneous heating of oily material, as follows:—

Refuse from processes	7
Rubbish near steampipes or boilers	4
Burlap bagging	3

Seven fires occurred in leach houses, being attributed to the following causes:—

Spontaneous heating from oils	1
Spontaneous heating of tan bark	1

Spontaneous heating of quebracho	1
Motor	1
Sparks from outside sources	2
Unknown	1

Three fires occurred from water in contact with lime.

Two fires resulted from sparks from the knives of splitting machines.

Seven fires resulted from miscellaneous special hazards, including degreasing, gas explosion, laboratory, electric flatiron, smoke house, sulphur burner, and linseed oil kettle.

The so-called common hazard fires in this class, which did not appear to involve the foregoing special hazard conditions, were listed as follows:—

Boilers and stacks	24
Electric wiring and motors	15
Smoking	10
Exposure	10
Incendiary	9
Sparks from locomotives, etc.	5
Lightning	2
Unknown and unclassified	48
	123

Taking 194 fires for which data was given, the frequency of fire in certain rooms or departments was indicated by another classification as follows:—

Drying	30	Finishing Room	11
Boiler House	29	Buffing	5
Hair House	18	Dust Box	5
Leach House	17	Others	68
Bark Mill	11		

This serves as a rough check on the conclusions to be drawn from the preceding tabulations.

2. Morocco Leather.

In the manufacture of morocco leather the ordinary first stages of tanning are followed by finishing processes including certain treatments with oils, and these give added distinctive special hazards.

Of 149 fires recorded in this class, 78 were found to be more or less definitely connected with special hazards, these being distributed as follows:—

Thirty-six were directly incident to the process of buffing, occurring at the machine or in the dust pipes or dust boxes connected therewith.

The immediate causes assigned included the following:—

Sparks from the wheel
Spontaneous heating of buffings
Hot bearings
Fans.

Seventeen occurred in dry rooms, the assigned causes including

Fans
Spontaneous heating
Smoking
Power.

The losses from these dry-room fires were serious in a number of cases. These fires do not include those which started outside dry rooms but extended into them and were difficult to handle on account of the conditions there.

Fifteen fires were attributed to spontaneous heating of factory rubbish including work clothes, and including cases in which material was against steampipes, etc.

Five fires illustrated the tendency to spontaneous heating of skins in piles, especially skins of certain characteristics or which had been subject to certain treatments.

Three fires resulted from leaving the current on electric flatirons used in ironing or polishing skins. One fire was due to bark grinding and one was due to boiling over of linseed oil being prepared as a finishing oil.

A separate tabulation of 112 fires for which data was given, including both common and special hazards as assigned causes, made on the basis of the rooms in which the fire occurred, gives the following table as a check on the conclusions to be drawn from the foregoing.

Drying Rooms	19
Buffing Rooms	19
Dust boxes	7
Finishing Rooms	7
Bark Mill	3
Leach House	3
Boiler House	13
Other rooms	41
	112

The common hazard fires or those not clearly distinguished as connected with special hazards were as follows:—

Smoking and matches	15
Boilers and stacks	11
Electricity (motors, etc.)	6

Sparks (locomotive, etc.)	4
Power (hot bearings)	4
Miscellaneous (stoves and torches)	3
Lightning	3
Exposure	2
Incendiary	2
Unknown	20
Total	70

3. Skin Mills.

Tanneries in this particular class are those devoted to the manufacture of glove leather. Few fires were recorded. Of those in connection with special hazard conditions, the distribution was as follows:—

Buffing	2
Spontaneous heating of skins	1
Charcoal heated irons	1
Total	4

A separate classification of eight fires showed the occurrence by workrooms as follows:—

Finishing Room	2
Dust Box	2
Buffing Room	1
Miscellaneous	3

The common hazard fires in this classification were as follows:—

Power	2
Smoking and matches	1
Chimneys	1
Sparks	1
Lightning	1
Miscellaneous	1
Total	7

4. Patent Leather.

Patent leather works may include rather extensive preliminary tanning operations or may be limited chiefly to the application of the japan, enamel, or pyroxylin daub and the subsequent baking, drying or finishing operations. The fires recorded emphasize the destructive hazard of the latter class. The hazard of the flammable liquid used overshadows the common hazards which form the immediate causes of the fires.

Twelve fires occurred in rooms or buildings devoted to the preparation of the daub or varnish.

Eight fires occurred in rooms where the daub or varnish was being applied. These include fires in naphtha, etc., used by workmen in cleaning hands or brushes in the coating room.

Five fires occurred in the handling of freshly daubed skins.

Five fires arose in the ovens or dryers.

Four fires occurred from circumstances not clearly reported, but in which naphtha vapor contributed to the rapid spread of fire.

Three fires started in oily cloths or waste used in connection with linseed oil daub, and in which spontaneous heating might be expected.

Summing the foregoing, it is found that 37 fires out of a total 71 fires in this class were due to the hazards of preparation, application or treatment of the daub.

In addition to these, 11 fires from ordinary tannery special hazards were found as follows:—

Buffing process	5
Dry lofts	3
Electric flatiron	1
Spontaneous heating of leather	2

The separate classification resulting from the tabulation of fires by room of occurrence in this class was as follows:—

Japanning or Daubing	17
Varnishing	2
Drying	6
Finishing	5
Oil boiling	5
Dust Box	2
Others	14
Total with data given	51

The common hazard fires in works of this sort were classified as follows:—

Chimneys and sparks	5
Smoking	2
Spontaneous ignition of rubbish	2
Spontaneous ignition of soft coal	1
Exposure	1
Lightning	1
Incendiary	5
Unknown	6
Total	23

Recapitulation.

The combined tabulations of special hazard fires in the preceding four groups of tannery properties indicate the relative frequency of fire from certain conditions as follows:—

Drying rooms or lofts	56
Buffing process	56
Flammable liquids in patent leather factories	35
Spontaneous heating of manufacturing wastes other than buffing	32
Spontaneous heating of skins	8
Bark grinding, etc.	23
Hair drying	18
Leach houses, miscellaneous	7
Electric irons, etc.	5
Lime	3
Splitting machines	2
Miscellaneous	7
	252

Common hazard fires in all four classes of tanneries were classified as follows:—

Boilers and their stacks	41
Smoking and matches	28
Power	27
Incendiary	16
Exposure	13
Sparks (from outside)	10
Lightning	7
Miscellaneous	7
Unknown	74
	223

It should be remembered that the basis of all these tabulations is somewhat different from that usually adopted, and that as far as possible the fires which were apparently started by common hazards but in special hazard surroundings have been classified as special hazard fires. This results in the depletion of the common hazard assignments.

Conclusion.

Without attempting to outline the special hazards of tanneries, attention may well be called to the prominence of the hazards of drying and buffing operations or conditions. The concluding tables do not, however, properly emphasize the importance of the insidious hazard of spontaneous

heating due to the materials employed. A review of the detailed tabulations of the four classes showed that out of 252 special hazard fires no less than 61 gave indication of this phenomenon, and it is not unlikely that it played a part in a number of fires in dry rooms and elsewhere, for which the immediate cause was unknown, or was otherwise given.

Sprinkler Tables.

The following tables, compiled by the N. F. P. A. Department of Fire Record, are arranged in usual form to show the relative efficiency of automatic sprinkler protection for this occupancy, the number of heads opened, etc. These tables also give data on losses, time of day and means of discovery of fires.

The tables show that automatic sprinkler protection, as might be expected from the severity of the hazard involved, is slightly less efficient in this occupancy than in the general average of all occupancies. The showing is favorable, however, with sixty per cent of all fires extinguished by the operation of five or less sprinkler heads. There is a greater difference here in the relative efficiency of wet and dry systems than in the general average tables, but the total number of fires reported in this class is not large enough to give minor variations in the percentage figures only special significance.

The table "Analysis of Loss," showing eighty-two per cent of all sprinklered fires extinguished with small loss, while only forty per cent of unsprinklered fires were extinguished with a loss under $5000, furnishes a striking testimonial to the value of automatic sprinkler protection for tanneries.

COMPARISON OF WET AND DRY SPRINKLER SYSTEMS.

	Morocco Leather		Patent Leather		Skin Mills		Tanneries		Total	
Wet Systems	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%
Extinguished Fire.....	20	54.0	9	39.1	1	100.0	30	50.9	60	50.0
Held Fire in Check....	14	37.9	11	47.8			27	45.7	52	43.3
Total Satisfactory.....	34	91.9	20	86.9	1	100.0	57	96.6	112	93.3
Unsatisfactory	3	8.1	3	13.1			2	3.4	8	6.7
Total	37		23		1		59		120	
Dry Systems										
Extinguished Fire.....	18	51.5	1	50.0	6	100.0	11	47.8	36	54.5
Held Fire in Check....	11	31.4	1	50.0			7	30.4	19	28.8
Total Satisfactory.....	29	82.9	2	100.0	6	100.0	18	78.2	55	83.3
Unsatisfactory	6	17.1					5	21.8	11	16.7
Total	35		2		6		23		66	

NOTE: There were two fires in which there is no data as to whether sprinklers were on wet or dry systems.

Number of Heads Opened.

No. of Heads Opened	Morocco Leather		Patent Leather		Skin Mills		Tanneries		Total	
	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%
1	19	27.4	6	24.0	2	25.0	19	23.5	46	25.0
2	9	13.0	4	16.0	1	12.5	12	14.9	26	14.1
3	8	11.5	1	4.0			10	12.4	19	10.3
4	6	8.6	2	8.0			4	4.9	12	6.5
5	4	5.7					4	4.9	8	4.4
6	2	2.8	2	8.0	1	12.5	1	1.2	6	3.3
7	3	4.3	2	8.0			1	1.2	6	3.3
8	2	2.8	1	4.0			2	2.5	5	2.7
9							2	2.5	2	1.1
10	1	1.4					1	1.2	2	1.1
11	1	1.4							1	.5
12	2	2.8					2	2.5	4	2.2
13			1	4.0			1	1.2	2	1.1
14	2	2.8			1	12.5			3	1.6
15							1	1.2	1	.5
16-25	2	2.8	2	8.0	1	12.5	8	9.9	13	7.1
26-35	2	2.8			1	12.5	1	1.2	4	2.2
36-50	2	2.8	1	4.0	1	12.5	2	2.5	6	3.3
51-100	2	2.8	2	8.0			4	4.9	8	4.4
Over 100	3	4.3					4	4.9	7	3.7
All			1	4.0			2	2.5	3	1.6
No Data	2		1				1		4	
Total	72		26		8		82		188	

Note: There were seventy-five fires in which no sprinklers operated.

Day or Night Fires. (Day Fires 6 A. M. to 6 P. M.)

	Morocco Leather		Patent Leather		Skin Mills		Tanneries		Total	
	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%
Day	81	55.1	37	52.1	5	45.5	118	46.6	241	50.0
Night	66	44.9	34	47.9	6	55.5	135	53.4	241	50.0
Total with Data	147		71		11		253		482	
No Data							7		7	
Total	147		71		11		260		489	

How Discovered.

	Morocco Leather		Patent Leather		Skin Mills		Tanneries		Total	
	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%
Employee	64	44.1	34	47.9	6	54.5	107	42.3	211	44.0
Watchman	32	22.1	21	29.6	3	27.3	89	35.2	145	30.2
Sprinkler Alarm	19	13.1	4	5.6	1	9.1	6	2.3	30	6.3
Supervisory			1	1.4					1	.2
Thermostat	3	2.1					4	1.6	7	1.4
Outsider	27	18.6	11	15.5	1	9.1	47	18.6	86	17.9
Total with Data	145		71		11		253		480	
No Data	2						7		9	
Total	147		71		11		260		489	

ANALYSIS OF LOSS.*

	Morocco Leather		Patent Leather		Skin Mills		Tanneries		Total	
Sprinklered Fires	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%	No. of Fires	%
Small Loss.....	85	85.0	24	64.9	9	90.0	97	84.4	215	82.1
Large Loss.....	15	15.0	13	35.1	1	10.0	18	15.6	47	17.9
Total with Data.....	100		37		10		115		262	
No Data.....	1								1	
Total	101		37		10		115		263	
Unsprinklered Fires										
Small Loss.....	17	43.6	10	40.0			48	39.7	75	40.4
Large Loss.....	22	56.4	15	60.0	1	100.0	73	60.3	111	59.6
Total with Data.....	39		25		1		121		186	
No Data.....	7		9				24		40	
Total	46		34		1		145		226	

* Large loss fires are fires causing damage greater than $5,000.00.

The Mills Hotel Fire.

Report by Robert M. Cadman.

(Member N. F. P. A.)

A fire which occurred at 9:35 A. M. on May 27th, 1924, partially destroyed the Mills Hotel and six stores at the southwest corner of William and Halsey Streets, Newark, N. J., and caused the death of six persons residing in the building.

The building was of joisted brick construction with floors, partitions, doors, window frames and stairs of wood. Ceilings were metal on plaster board. One open stairway extended from the first to the fourth floor. There were two iron fire escapes, one on Halsey and one on William Street.

The first floor was occupied by six stores. The second, third and fourth floors were used for sleeping rooms. Of these there were 21 on the second floor, 42 on the third floor, and 57 on the fourth floor. These rooms were from 5 ft. x 6 ft. 4 in. to 6 ft. 10 in. x 8 ft. in size with wooden partitions as side walls. The hotel or lodging house had sixteen patrons at the time of the fire.

Story of the Fire.

The fire started at the foot of the stairway on the first floor. The actual cause has not been determined, but disinfecting fluid, which was being drawn from a metal drum, became ignited. The fire spread rapidly, extending up the stairway to the fourth floor, where it mushroomed, involving all three floors. At 9:39 A. M. a second alarm was sounded, followed shortly by a third alarm. On the arrival of the first company,

The Mills Hotel building in Newark, where six persons lost their lives in a fire occurring at 9:30 A. M.

dense smoke and flames were issuing from windows on the three upper floors and men only partly clad were on the fire escapes trying to reach the ground in safety. In spite of the good work by the Fire Department six men lost their lives from suffocation. Eleven engine companies responding laid twenty-six lines of hose and three truck companies raised 449 feet of ladders.

The disinfecting fluid being highly volatile and flammable was responsible for the rapid spread of the fire, and the wooden stairway and partitions furnished plenty of ready fuel for the flames. The density of the smoke made it impossible for the six who lost their lives to find an exit, four having been found in a lavatory on the fourth floor, near the stairway. According to one of the survivors these four passed an available fire escape on their way to the point where they met their death.

In view of the fact that there were only sixteen lodgers in the building at the time of the fire it is reasonable to suppose that the fire escapes were of ample capacity for the needs of this fire.

The smoke issuing from the windows resembled that from a paint or oil fire, probably due to the heavy coating of paint on the woodwork and also to the composition of the disinfectant which resembled a crude distillate containing toluol, benzol and tarry oils.

This fire brings to our attention the necessity of not only making laws relative to the transportation and storage of flammable liquids but insisting on their enforcement.

The Sterling Products Co. Fire.

Report by Indiana Inspection Bureau.
(Member N. F. P. A.)

The fire in the plant of the Sterling Products Company, Evansville, Ind., on July 19, 1924, is notable principally by reason of the damage done to the reinforced concrete structure during a fire which, according to available evidence, did not develop especially high temperatures. This building, erected in 1914, was designed for the bottling department of a brewery, but had not been used for this purpose since 1921, at the time of the fire being occupied principally for furniture storage. The loss on the building was $98,000, which represented about one-third of the value of the structure, and on the contents $237,000, which represented nearly a total loss.

Construction.

As the illustration indicates, the building was four stories and basement with outside brick panel walls, the interior being of standard reinforced concrete construction. The size is 104 x 240 feet with no fire walls or other interior divisions, except wooden partitions and two partial partitions of metal lath and cement plaster on the second floor. While at the ends of the building there were standard stair towers, various unprotected vertical openings made the entire structure substantially one fire area. These openings included an unprotected elevator shaft, openings for chutes and gravity conveyors, and a large open well 90 x 100 feet in the second floor. Except for the absence of cut-offs, the building was apparently of good construction, and the concrete, a 1:2:4 mixture with a gravel aggregate, was properly mixed and placed. The reinforcement was sufficient, the cover being one inch on the floor slabs and from one and one-half to two inches on the columns. The columns, which were of the mushroom type as is indicated by the illustrations, were octagonal in shape and were from 22 x 22 in. to 26 x 26 in. The brick panel walls between the reinforced concrete columns and girders were 12 in. thick.

Occupancy.

While there had been no bottling done in the building since 1921, some of the washing and bottling equipment is still in place on the first floor. The building has since been rented to local concerns for storage of surplus stocks, the only active industry being a small medicine compounding plant in the west 80 feet of the second floor, employing two or three hands. The building owners did not supervise the storage or shipment of goods of most of the occupants, but merely rented space to be

utilized as they desired. There were no restrictions against trespassers in the daytime.

The occupancy at the time of the fire was about as follows:

BASEMENT: Occupied entirely by one tenant for storage of crated stoves, utilizing space to entire capacity.

FIRST FLOOR: Two occupants, one with relatively small stock of wholesale groceries of all descriptions, the other with a small stock of crated and wrapped furniture.

SECOND FLOOR: Lightly occupied in part, there being a vacancy in east half of building except a small space given over to offices. In west end, however, a very congested state of occupancy existed in the premises of a flour packing concern, flat paper cartons and flour sacks being piled to ceiling height, and on the old unused conveyor installation.

THIRD FLOOR: Heavily stocked with crated and paper and excelsior wrapped furniture. Irregular service aisleways were said to exist but goods are reported to have been piled in front of windows in general. Goods were piled to ceiling height.

FOURTH FLOOR: On same order as third floor except perhaps not quite so heavily stocked.

Protection.

PUBLIC PROTECTION: Public water supply in the vicinity of the plant is considered good, there being three hydrants within 300 feet and four others within 500 feet, on 6, 8, 16 and 24-inch mains; normal pressure of 45 pounds is increased to 80 pounds at the pumping station for fire service, the suction pressures on pumpers during the fire being from 60 to 70 pounds. The response of the fire department to the district consists of three pumper companies, one hose company and one ladder company on first alarms; one pumper company is located within three blocks and four other stations are within 10 to 13 blocks.

PRIVATE PROTECTION: A 4-in. standpipe is provided with 50 to 100 feet of 2½-in. unlined linen hose attached in each floor, which is fed by city mains through a 4-in. connection. Approved 2½-gallon chemical extinguishers were provided in some portions, insufficient in number for adequate protection. These played no part during the fire, although the firemen ran out the hose in the first floor but it burst when the valve was opened.

WATCH SERVICE: A watchman made hourly rounds during nights only.

Story of the Fire.

All employees left the building about noon, as is usual on Saturdays, with the exception of one man who was working at the desk adjoining the stair shaft at the southeast corner of the first floor. One of the workmen from another storehouse entered the building at this point shortly after

4 o'clock and saw smoke coming down the elevator shaft at this corner. He spoke of it to the other man and they both went up the elevator to the fourth floor and traversed this floor to the large open elevator shaft at the center of the building, but saw no smoke there so returned to the first floor. They then walked to the west end of the first floor and saw burning pieces of cartons falling down the spiral conveyor from the second floor. They called to a man outside to telephone the alarm and proceeded to open one of the shipping doors on the south side to admit firemen from a pumper and a ladder company, in charge of an assistant chief, who arrived from the station three blocks distant.

A chemical line was carried into the building, followed by a water line which was taken up to the second floor in the open well, but it was found that the fire had spread to the third floor and the assistant chief ordered a second alarm; a street box was pulled in the meantime, also the alarm sent through a watchbox in the engine room. The time stamp at fire alarm headquarters shows that the still alarm was received at 4:11, box alarm at 4:15, A.D.T. alarm at 4:21, and second alarm at 4:25 P. M. The box alarm called two additional pumper companies and a hose company and the second alarm two more pumper companies, a hose company and an aerial truck. The chief responded to the second alarm. Additional apparatus was summoned later by telephone.

Attempts were made to enter the third floor from the stair towers, but the dense smoke drove the men back. The door to the fourth floor was locked or blocked so it could not be opened. Hose streams from pumpers were directed at the windows of the third and fourth floors on the north side. The windows were broken, either by the streams or by bricks which were thrown. It was found that furniture had been piled almost to the ceiling at all of the windows, blocking the openings so that the water had little effect. On the south side a hose line was taken to the fourth floor on the aerial ladder, only to find the window blocked with stock, as were all of the windows in the east half on this side in the third and fourth floors. The stock in both floors was piled almost to the ceiling in many places, also there was a low partition through the center of each floor extending from the west end to the large elevator. Effective work could not be done from ladders by this time as the heat and smoke were intense. Two lines were run to the roof, but were of little value. Ventilation through the roof was possible only by opening the wired glass windows at the sides of the elevator monitors and this was only partly done. Hose lines from pumpers were played through the windows on the upper floors, from the street level or from nearby roofs, with little effect in the interior of the building as evidenced by the bursting out of flame when hose was shifted from window to window. A turret nozzle supplied by three lines from a steamer and a deck pipe supplied by two

The Sterling Products Co. building, view from southwest corner. Note undamaged wired glass windows at stair and elevator towers at corner; all other windows were of ordinary glass.

pumper lines mounted on a hand drawn wagon, were used on the south side with more effect. During the period of the fire the wind was from the southeast, velocity about six miles per hour, temperature about 72 degrees.

The fire was probably most intense about 7 o'clock, after which time the cooling effect of the water gradually became apparent with heavier smoke, and although attempts were made at times to enter the upper floors with hose lines it was not until about 5:30 A. M. that this could be done. One man was overcome by smoke, but was soon revived without injury. Firemen state that even at this time the heat in those floors was almost unbearable and the fourth floor was so hot that it burned them through the soles of their boots. Overhauling and wetting down was continued all of the following day. A total of about 15,000 feet of hose was used during the fire.

Damage.

The damage to the building was probably due not so much to the high temperatures developed as to the long continued heat which penetrated into the interior of the structural members, and to the contraction of the outside surfaces from streams of water. This is evidenced by the fact that no metalwork was fused, such as pipe coils and rods, also the sheet metal cabinets and copper bars and fuse bases of the electric panel boards were not fused, although the concrete on the columns to which

A corner of the third floor. Note typical damage to column at left.

they were attached had broken away from the spiral reinforcement.

The building is apparently undamaged below the third floor. The damage to the fourth floor and columns below was heaviest in the west half, where floor slabs are distorted, being buckled both up and down, insulation on columns cracked off and broken away from the spiral winding in long slabs and the column caps and pads above are badly spalled off, the latter in some cases practically flush with the face of the slab. The sagging of the slabs in the west section is fairly uniform in the center between columns, in both directions without breaks, while the sharp breaks where the slabs buckled up toward the east end occur transversely, probably due to the resistance of the cooler portion against the lateral movement from expansion of the heated portion. The under sides of the slabs are considerably broken away, mostly transversely, for a space about a foot wide, at the point five feet from the column centers where the bend in the rods occurs. Columns are seemingly forced out of line but accurate

Fourth floor, east end; showing damage to roof.

measurements have not been made. The walls are somewhat distorted and cracked in several places, particularly the north, east and west. In the northwest and southeast corners, where concrete stairs in 4-in. concrete towers are located, the shearing effect is shown by cracks in the brick work and in the tower walls; the latter having been forced away from the stairs.

The damage to the roof and supports is more severe toward the east half. Slabs are bowed down except where expansion joints were placed, where they are buckled up. The general damage as to breaking away of column covering and slabs and spalling of column caps is similar to that in the third floor. The south wall was forced outward near the center at the roof line, badly spalling the limestone cornice trim and dislodging one of the stones.

Observations.

The cause of the fire has not been determined. It is the opinion of the first observers that it originated at the unused spiral conveyor in the second floor at the west end of the building. This conveyor has an opening 11 feet in diameter through the second floor and one which is about 3 x 5 feet through the third floor. When first discovered the flat cartons which were stored on the conveyor, some in bundles and some loose, were burning and dropping through to the first floor. No cause is known for fire to have started in these cartons and it is possible that a

match, cigar stub or other burning matter might have dropped from the floor above. There was evidently little or no fire on the third floor when the men first investigated as they saw no evidence at the open elevator shaft in the fourth floor.

The rapid spread of the fire to the third and fourth floors was to be expected, due to the numerous unprotected openings, the nature of the stock and excessive areas exposed.

The lack of supervision by the building owners of the handling and piling of stock created the hazard of dense piles of highly combustible stock piled almost to the ceilings, completely blocking the entrance of firemen through the windows and rendering hose streams ineffective. There was no one in authority present during working hours to enforce safety rules or to prevent intrusion, and no watchman was on duty on holidays. Stair and elevator shafts at the corners of the building were provided with good metal doors but these were left open.

The lack of watch service caused delay in discovery of the fire and transmission of the alarm.

Examination of the broken floor slabs where the rods are exposed shows at least one inch of covering in all cases; on the columns the covering is at least one and one-half inches on the flat sides. The corners of the columns are not badly spalled but the material cracked at the thinnest part and peeled off down to the spiral winding. The spalling of the column caps and pad above was probably due to dehydration and disintegration from heat and water due to the large mass of concrete at these points. The concrete shows a good homogeneous mix, the gravel aggregate well distributed, and there is practically no evidence of cracking of the aggregate. The adhesion between cement and gravel seems good, as also is the adhesion of the metal and concrete.

Conclusions.

The conversion of idle buildings of this type, with machinery still in place and passing through floors, into storage warehouses, without such changes in construction as will provide reasonable measures for fire safety consistent with the new occupancy so depreciates the value of the superior construction as to render them liable to heavy damage. This was clearly demonstrated in the present instance. The building was considered a model of its type, as a bottling works; materials and workmanship are said to have conformed to best practice. The mass of combustible stock, however, made it unable to resist the effects of fire and water.

The fire department did not make periodic inspections of the property and did not follow up their recommendation made some time ago to provide proper passageways at the windows. Such inspections as were made were by inspectors sent from headquarters and none were made by

officers in the district. As a result the first companies arriving were handicapped by being unfamiliar with the interior of the building.

The importance of standard watch service, particularly the first few rounds immediately after business is suspended for the day, is emphasized. The smoke was first noticed in a remote corner of the building four hours after the men left the building.

Spontaneous Heating of Powdered Soap.*

An interesting case of spontaneous heating occurred in a large soap factory recently. A slow charring or smouldering fire occurred in a number of cases containing about twelve 40 lb. paper bags of U. S. P. powdered castile soap. There was little or no actual flame. The soap merely blackened and charred and the brown paper bags charred. The wooden cases were only slightly charred or discolored.

The fire was clearly a case of spontaneous heating of the soap. It took place mainly in the outside of the mass of soap next to the bags. The soap was made by saponification of pure olive oil with caustic soda by the boiling process.

A sample of soap (Sample 1) which showed no discoloration or effect of heating and a sample of soap (Sample 2) from one of the bags of the lot which was damaged were analyzed.

	Sample 1	Sample 2
Odor	Sweet	Rancid
Free Alkali	.01%	None
Free Fatty Acids	None	.23%
Free Fat	1.22%	1.65%
Unsaponifiable	.06%	.15%

The rancidity and development of free fatty acid was apparently due to a slow oxidation. The soap, as made, is saponified with an excess of alkali, and then washed free from alkali. This always leaves a small amount of free fat present in the soap, generally less than one per cent. There are no free fatty acids left in the soap, but these develop as rancidity occurs.

An interesting proof that slow oxidation took place is furnished by a determination of the Iodine Numbers[1] of the fatty acids obtained by cracking the soap. They run as follows:

Undamaged, white	Iodine Number 80
Rancid, white	Iodine Number 73
Tan, slightly colored	Iodine Number 52
Black, a scorched lump	Iodine Number 41

* Data obtained from a report by E. L. Ballard (member N. F. P. A.), Engineer, Underwriters' Bureau of the Middle and Southern States.

[1]The Iodine Number indicates the percentage of unsaturated fatty acid in the soap, and therefore indicates the ability of the soap to absorb oxygen.

The manager of the department stated that this was the first case of spontaneous heating of castile soap that has been experienced in this plant, although hundreds of similar batches of soap have been made over a period of several years.

A similar instance was noted in *The American Perfumer,* as follows:

M. Wegner, writing in *Chemische Unschau aus den Gebieten der Fette, Oele,* etc. (Vol. 29, pp. 119 and 127, 1922), describes an interesting case of spontaneous heating in "sapo medicatus." In the storeroom of a wholesale drug firm was a case, standing by itself, containing bags holding five kilos each of medicinal soap powder. Suddenly steam was observed issuing from the case. The soap in the one heated bag was baked together, almost black at the bottom, resembling montan wax * in color and consistency. The cause of the spontaneous heating could not be discovered. The soap had normal composition and properties. No separation of carbon had taken place in the heated soap. A chemical examination of the latter showed that an extensive lactone formation had taken place in the fatty acids, the petroleum ether soluble portion having a saponification number of 28.5, while the petroleum ether insoluble portion had a saponification value of 67.9. Simultaneously an alteration in the molecular weight, or rather, the equivalent weight of the fatty acids, had taken place, which, instead of the normal 280 for olive oil, was 298 in the petroleum ether soluble fatty acids, 214 for the insoluble. Theoretically, spontaneous heating might take place on account of the double bond in the oleic acid. Control experiments showed that the usual soap powder, the same powder extracted with ether and thus freed from neutral fat, and also the fatty acids derived from it, all were subject to sudden spontaneous heating when warmed in an air bath to 100-150° C. It has, therefore, been conclusively shown that dry soap powders prepared from oils are liable, when externally heated, to undergo spontaneous heating and seriously deteriorate in value. It has further been shown that this spontaneous heating is probably due to the content of unsaturated acids in the olive oil, and is an intrinsic property of the fatty acids. It was no longer possible to discover why in the present instance, this spontaneous heating had taken place without access of heat from the outside. No catalyzing substances were found.

* A dark brown wax derived from extraction of lignites and used as a substitute for carnauba wax.

Old Hickory Powder Plant Fire.

Report by Tennessee Inspection Bureau.

(Member N. F. P. A.)

The Old Hickory Powder Plant was built in 1918 by the United States Government for the manufacture of smokeless powder, and was 90% complete when the armistice was signed. It cost $85,000,000. The plant is located about twelve miles north of Nashville, Tennessee, in Hadley's Bend of the Cumberland River, with the entire area consisting of approximately 5,100 acres.

This property was purchased from the government by the Nashville Industrial Corporation in the fall of 1920, for the purpose of selling or leasing parts of the manufacturing and housing areas to individual manufacturing concerns and selling them power, water, fire protection, etc.

The United States Government reserved the right to use certain buildings within the plant area for the purpose of storing smokeless powder, of which there was a total of 94,000,000 pounds within the reservation limits at the time the above corporation took over the property. Only a comparatively small amount had been removed up to the date of the fire. About one-half of the powder was stored in specially constructed powder storage buildings, well detached, in the Powder Field, west of the plant area, and the remainder, or 45,000,000 pounds of nitro cellulose powder was stored in the sixteen buildings constituting the Solvent Recovery group located at the extreme northeast corner of the manufacturing area, where this fire occurred.

The construction of the sixteen one-story buildings comprising this group was skeleton iron-clad, metal roofed. Each of the sixteen buildings was approximately 40 feet wide by 700 feet long, and divided into sections of 100 feet each by 13-inch brick walls parapeted and T 'd. These units were separated at the ends by 100-ft. spaces with brick walls facing, and by a clear space of 200 feet between the rows. The total burned over area was practically 100 acres.

The area was fenced off by the government and mounted guard patrol was maintained at all times. It was by one of these guards that the fire was discovered about 5.20 A. M., Sunday morning, August 10, 1924, the point of the origin being in Solvent Recovery Building No. 12, at the extreme east end of the group. (Right background of the illustration on this page.)

The alarm was promptly sounded by means of a fire alarm box nearby, and responded to by two fire companies maintained for the pro-

Ruins of the Old Hickory Powder Plant. The fire walls, dividing the Solvent Recovery Buildings where the smokeless powder was stored, are 100 ft. apart. As the picture shows, they were of no value in preventing the spread of the fire.

tection of the plant, the apparatus consisting of motor equipment in the charge of more or less experienced firemen.

The fire, when first discovered, was hardly more than a small puff of smoke, yet by the time the first apparatus arrived from only a short distance away, the fire was spreading so rapidly that the fire chief could readily see that, notwithstanding the clear space and separating brick walls, the entire group of buildings containing powder was doomed, and promptly ordered that the exposed buildings on the south or plant side (side from which the above photograph was taken) should be protected, and that all energy possible be reserved to prevent the spread of the fire beyond the Solvent Recovery buildings containing the powder.

Adequate water and pumping facilities had been provided for fire protection during the construction and operation of the powder plant, in fact the original installation would have served ordinary consumption for a city of one million people, and while all of the original pumps were not available, still there remained sufficient pumping capacity for any ordinary fire that might occur on the premises.

To protect these buildings during the days of powder manufacturing a system of open sprinklers was installed inside the buildings; also outside as a water curtain. Both systems were controlled by "quick opening" valves under separate control and located outside of the buildings. The water supply for the interior sprinklers had been cut off when the powder was stored, but the curtain sprinklers were left intact with the

control valves in ground pits midway between the rows or 100 feet from the buildings.

Without orders from the fire chief the government guards and others began opening these valves controlling four-inch connections to the sprinklers. According to the fire chief, there were more than 100 of these valves opened before the orders to close them could be executed.

The heat from the burning powder was so intense that the water curtain could have been of no avail. With such large number of four-inch lines open, besides the fire hydrants in use, the system was simply bled dry of water, there being not more than 2,000 gallons available through the pumps at any one time. This low pressure obtained for about thirty minutes, but it is not thought that this occurrence contributed to the ultimate loss caused by the fire as the firemen under the most favorable pressures could not approach the buildings sufficiently close to apply the water to the body of the fire. It is the statement of the fire chief that the 200-ft. clear space served to no purpose in preventing the spread of the fire; in fact the heat wave on the south was so severe that metal-clad buildings 300 feet distant from the burning powder were ignited. One of the interesting events of the fire, as relates to its spread, is the statement of those witnessing the blaze, that once the fire was started, and due to the extreme heat from the burning powder, the exposed buildings containing powder ignited from within because of heat banking in the various sections, transmitted through the metal sides and roof, also through small openings in the separating brick wall, and when the heat reached the fusing point of the powder (contained in metal cans) the building vented itself by the roof being blown approximately 100 feet in the air and powder spread in all directions. However, once released from the containers, the powder did not burn so freely after being spread on the ground, and after the fire many of the larger grains were found only partially consumed.

Approximately seventy-six buildings with their contents were destroyed by the fire, the greater number of which contained smokeless powder. A few of the smaller buildings south of those containing the main portion of the powder were being used for the purpose of storing heavy machinery owned by private concerns. The greatest single loss, outside of the powder area, was that of the Refrigerating Plant, which contained valuable machinery.

While the waterworks system was subject to several interruptions during the fire from various causes, the records show that at no time was all of the pumping capacity out of service, there being both steam pumps and electrically operated pumps available, and after a careful analysis it is agreed that the fire did not spread beyond the point that might reasonably be expected in the face of such heat. Fortunately, there was practically

Remains of the iron-clad buildings destroyed in the Old Hickory Powder Plant fire.

no wind blowing at the time the fire began, but about 10 A. M. a slight breeze sprang up from the northeast, and aid was then requested of the fire department of Nashville, which responded with apparatus and firemen in charge of the Nashville chief. The fire was well under control by that time, however, and did not extend beyond the bounds already established. The Plant fire department did all to control the fire that could reasonably be expected, good judgment having been shown at critical moments.

The cause of the fire, as determined by a government investigating committee, was the spontaneous ignition of unstable nitro cellulose powder.

The greatest loss occasioned by this fire is sustained by the United States Government, due to the reservation contained in the deed to the Nashville Industrial Corporation to the effect that the United States Government shall hold the said Corporation harmless against any and all loss or damage which may arise as the result of the storage or removal of any property of the United States from the said premises. The government loss, as determined by the investigating committee, is fixed at $25,000,000. The fire insurance policy forms do not apply to any building used by the government; therefore the loss to the insuring companies will not exceed 10% of the amount written, or about $125,000 out of a coverage of $1,300,000.

It cannot be said that any new lessons have been learned from this fire, because it is a recognized fact that powder should never be stored in such great quantities within exposing distances, and that nitro cellulose powder is subject to deterioration and becomes unstable in about five

years, which is likely to bring about a condition productive of spontaneous ignition. This was known to be a temporary storage, but has all along been recognized as a serious menace which jeopardized this entire plant, and recommendations have been repeatedly made to remove the powder to the regular powder storage field, but to no avail.

The sprinkler installation doubtless would have served the original purpose of protecting these buildings because there would have been a comparatively small amount of powder in them passing along in process, but with the buildings stored full of powder there was no hope of the open sprinkler system controlling the fire, and it was never so intended.

Fires in Which There Was Loss of Life.

These notes are intended to point out typical conditions under which loss of life has occurred, that they may be known and guarded against.

Gasoline and Oils.

S-37044. PEABODY, MASS. A small night gang was at work in a naphtha degreasing plant connected with a tannery and just previous to the fire had finished degreasing the stock in one of the tanks. The cover of the tank had been removed and in their haste to finish up the work it is quite likely that a sufficient time was not given to thoroughly air out this tank. About two dozen skins had been removed when the foreman of the gang started to hang up a portable lamp, on a projection of a blower pipe near the tank. This portable lamp was arranged with a vapor proof globe and also protected by a wire cage. There is a possibility that the vapor proof globe had been removed. The foreman carelessly dropped the portable lamp on the floor, this landing about four feet from the degreasing tank and to one side. A flash of fire shot around to the front of the tank and this was followed by a wall of flame shooting out of the degreasing tank. There were two men in or at the entrance of this tank and they with another employee standing about four feet from the tank were blown several feet, landing against large racks of skins. These three men died the next day from their severe burns. The force of the explosion blew out most of the opposite wall of the building. The ensuing fire was promptly checked by the opening of nineteen sprinkler heads.

H-20517. MONTREAL, P. Q. A woman poured kerosene on the fire; An explosion followed. Hearing her screams, her son, who was an invalid, rushed to her aid and first attempted to extinguish the blaze with water. Finding this useless he tried to beat out the flames with his hands and dragged the woman out of the room. He had not succeeded in his plucky attempt when his heart failed and he fell at the feet of his mother with his own clothes ablaze. The woman died in a hospital the next day.

H-20681. BRIDGEPORT, CONN. Six children were burned to death in a night fire which was started by the explosion of an oil stove in their home, a converted barn. Four of the children were burned to death as they slept; one had apparently been awakened but was unable to escape. The father with the eldest child in his arms, his clothing ablaze, succeeded in getting out of the house, but the child died the next day. The intense heat forced firemen to fight the flames from a considerable distance. An hour passed before the first victim was taken from the building. The body was found leaning against the wall as though the boy had tried to reach a window several feet away. The bodies of the other children were recovered shortly after and by the time the body of the last one was brought out the building had burned to the ground.

H-20526. BLENHEIM, CANADA. Two children lost their lives when their home was completely destroyed by fire. The fire was caused by the overheating of cylinder oil which had been placed on the kitchen stove to warm up for use. This oil burst into flames and cut off the means of escape of the children. The eldest child apparently reached the door in safety and turned back to help her little sister, when both were overcome by smoke. The father rushed into the house to help rescue the family and was severely burned about the face and neck. The mother escaped unharmed, but the grandmother was terribly burned on the arm.

The house, a temporary structure, was completely destroyed.

A Watchman.

S-37328. ERIE, PA. Fire started in an unsprinklered portion of a brass and copper tube factory and aided by an extremely heavy wind spread with such rapidity that the plant was practically destroyed. One of the most interesting points of the fire was that the floors, which were mainly of wood block on earth or concrete, burned as fiercely as the roofs which were for the most part plank on steel trusses. There is no knowledge as to the cause of the fire.

For two days after the fire was over it remained a mystery as to the fate of the watchman. After two days' search, his skeleton was found in a corner of the plant where it is presumed he was trying to extinguish the fire.